Agilent 8703B
Lightwave Component Analyzer
Reference

Agilent Technologies

Notices

Manual Part Number

08703-90059

Edition

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Agilent Technologies, Inc.
Digital Signal Analysis
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Santa Rosa, CA 95403, USA

Warranty

Safety Notices

CAUTION

Caution denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in damage to or destruction of the product. Do not proceed beyond a caution sign until the indicated conditions are fully understood and met.

WARNING

Warning denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a warning sign until the indicated conditions are fully understood and met.

Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent Technologies further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

General Safety Considerations

This product has been designed and tested in accordance with the standards listed on the Manufacturer's Declaration of Conformity, and has been supplied in a safe condition. The documentation contains information and warnings that must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

WARNING **If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) only.**

WARNING **No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock, do not remove covers.**

Safety and Regulatory Information

For safety and regulatory information, see "Laser Safety Considerations" on page 1-15 and "Regulatory Information" on page 1-18

Contents

1

Specifications and Regulatory Information

Specifications and Characteristics

Specifications apply to instruments in the following situation:

- temperature is in the range of +20°C to +30°C
- analyzer has had a warm-up time of two hours in a stable ambient temperature
- measurement calibration has been performed

Performance Definitions

Specifications: Warranted performance. Specifications include guardbands to account for the expected statistical performance distribution, measurement uncertainties, and changes in performance due to environmental conditions.

Characteristics: Useful, non warranted, information about the functions and performance of the system.

Calibration Cycle

Agilent Technologies warrants instrument specifications over the recommended calibration interval. To maintain specifications, periodic recalibrations are necessary. We recommend that the analyzer be calibrated at an Agilent Technologies service facility every 12 months.

User Calibration Cycle

A user calibration, also known as a measurement calibration, should be performed at least once every 8 hours. If the ambient temperature drifts, then you should perform a calibration more frequently.

8703B Performance Data

8703B Performance Data		
Description	**Specification**	**Characteristic**
Lightwave Source		
Wavelength Option 155 Option 131	 1555 nm, ±5 nm 1308 nm, ±9.5 nm	
Average Optical Output Power from Laser		+5 dBm
Laser Beam Divergence		12%
Spectral Width		< 20 MHz
Modulation Bandwidth	0.05 to 20.05 GHz	
Modulation Frequency Resolution	1 Hz	
Maximum Optical Power Input to Modulator	10 dBm (10 mW)	
Insertion Loss of Modulator		9 dB
Average Optical Output Power from Modulator		–4 dBm (400 μW)
Modulated Signal Output Power from Modulator (p-p)		–7 dBm (200 mW)
Modulation Index[a]		40% to 100%
Optical Output Return Loss (for all front panel optical ports)		> 30dB
Lightwave Receiver		
Wavelength	1000-1600 nm	
Input Modulation Bandwidth	0.05 to 20.05 GHz	
Maximum Average Input Power Operating Level	+3 dBm	
Input Port Return Loss		>30 dB
Microwave Source		
Frequency Bandwidth	0.05 to 20.05 GHz	
Frequency Resolution	1 Hz	
Output Power Range	–65 to +5 dBm	
Microwave Receiver		
Frequency Bandwidth	0.05 to 20.05 GHz	
Maximum Input Power Operating Level	+10 dBm	

a. Modulation index is calculated as: maximum signal power/average power.

Measurement Conditions

The specifications in the following section apply for measurements made using these conditions:

- 30 Hz IF Bandwidth
- Stepped Sweep Mode
- Autobias ON
- 0.5% Smoothing

Optical-to-Optical Device Measurement Specifications

The following data applies after a response and isolation calibration has been performed. Connectors should be HMS-10 or equivalent.

O/O Noise Floor

Optical-to-Optical Measurement Performance Data		
Description	**Frequency Range**	**Noise Floor (dBo)**
Maximum Noise Floor Amplitude[a]	0.05 to 8 GHz	–30
	8 to 20 GHz	–25

a. Noise Floor is measured with 30 Hz IF bandwidth and with an averaging factor of 6.

Optical-to-Electrical Device Measurement Specifications

Relative frequency response can be used to calculate the error in measuring the 3 dB bandwidth of an O/E device.

Relative Frequency Response Performance Data

Optical-to-Electrical Measurement Performance Data		
Description	**Frequency Range**	**Specification[a]**
System Relative Frequency Response Accuracy	0.05 to 11 GHz	±0.65 dB
	11 to 20.05	±0.90 dB

a. Applies to a device with ρ = <0.25 and measurement settings of IF bandwidth = 30 Hz and smoothing = 0.5%.

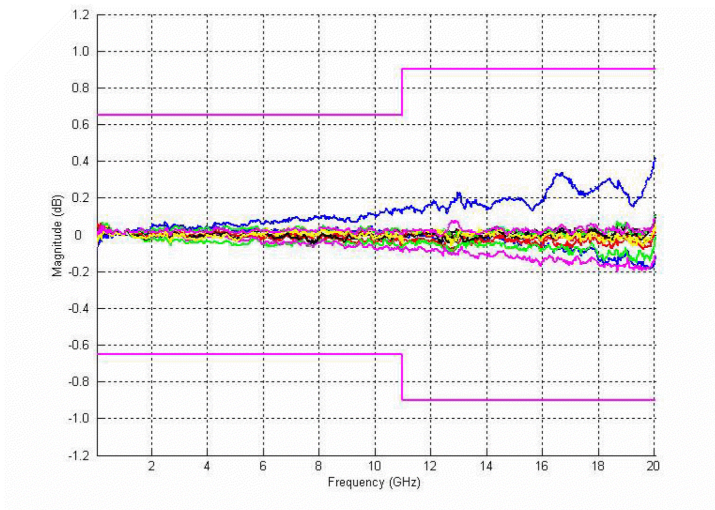


Figure 1-1. O/E Port 1 Characteristic Relative Frequency Response Error

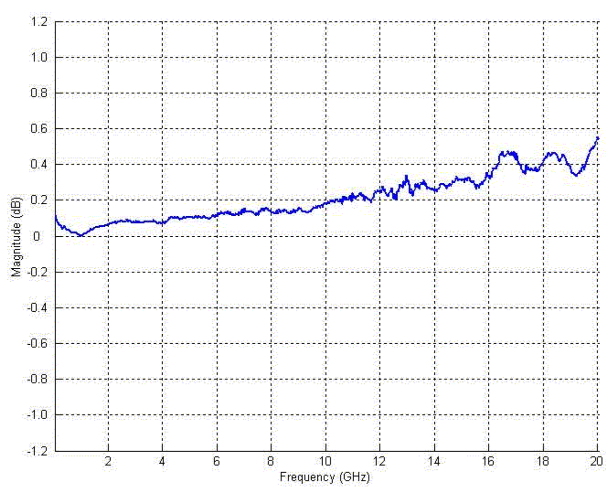


Figure 1-2. O/E Port 1 Characteristic Peak-to-Peak Repeatability

The above graph shows the worst case deviation across a 20 GHz span between any 2 units in a sample set of 12.

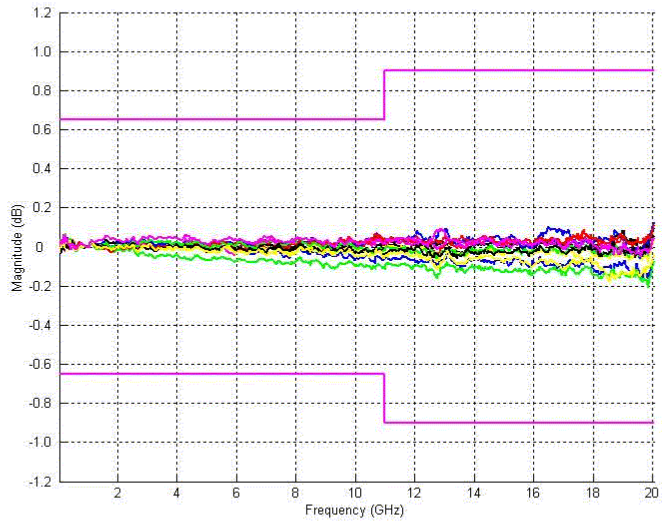


Figure 1-3. O/E Port 2 Characteristic Relative Frequency Response Error

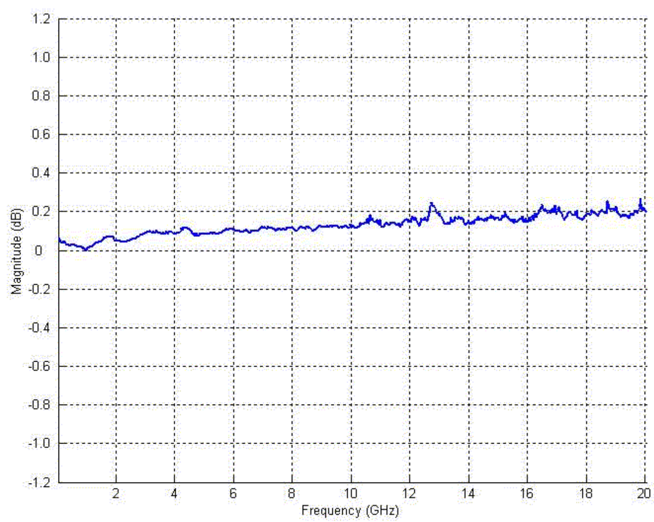


Figure 1-4. O/E Port 2 Characteristic Peak-to-Peak Repeatability

The above graph shows the worst case deviation across a 20 GHz span between any 2 units in a sample set of 12.

O/E Frequency Response Error for Different Reflection Coefficients

A significant error term in this measurement is the electrical port match of the device under test (DUT). The following table lists the measurement uncertainty as a function of DUT electrical reflection coefficient. On PORT 1 measurements, you can perform response and match calibration to achieve values comparable to measurements of devices with ρ = < 0.25, as shown in "Relative Frequency Response Performance Data" on page 1-4.

Optical-to-Electrical Relative Frequency Response Versus ρ		
Frequency Range	**r < 0.5 Specification**	**ρ < 1.0 Specification**
0.05 to 11 GHz	± 1.25	± 2.35
11 to 20.05 GHz	± 1.70	± 3.5

System Dynamic Range Characteristics and Responsivity Measurement Range

The following table shows the maximum and minimum values of the O/E device under test (DUT) frequency response.

Optical-to-Electrical Measurement Performance Data		
Description	**Frequency Range**	**Characteristic**
System Dynamic Range	0.05 to 0.84 GHz	77 dB
	0.84 to 20.05 GHz	100 dB
Responsivity Measurement Range[a]	0.05 to 0.84 GHz	Maximum Value +43 dBe (A/W)
		Minimum Value –34 dBe (A/W)
	0.84 to 20.05 GHz	Maximum Value +43 dBe (A/W)
		Minimum Value –57 dBe (A/W)

a. Pertains to a 10 Hz IF bandwidth.

Electrical-to-Optical Device Measurement Specifications

Relative frequency response can be used to calculate the error in measuring the 3 dB bandwidth of an E/O device.

Relative Frequency Response Performance Data

Electrical-to-Optical Measurement Performance Data		
Description	**Frequency Range**	**Specification[a]**
System Relative Frequency Response Accuracy	0.05 to 0.5 GHz	±1.15 dB
	0.05 to 11 GHz	±0.85 dB
	11 to 20.05 GHz	±0.90 dB

a. Applies to a device with ρ = <0.25 and measurement settings of IF bandwidth = 30 Hz and smoothing = 0.5%.

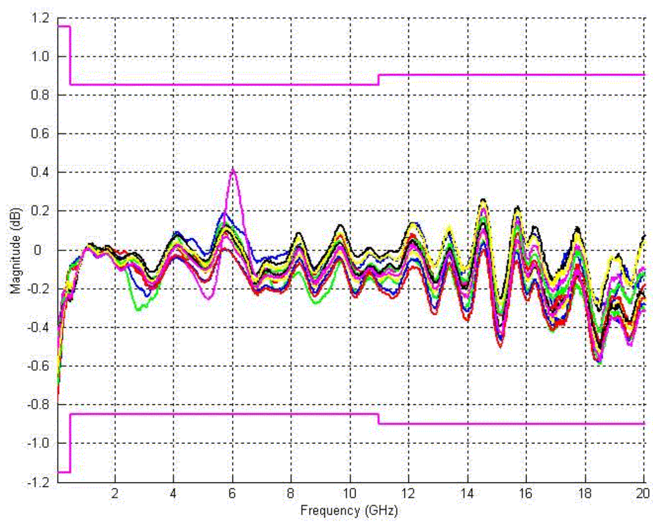


Figure 1-5. E/O Characteristic Relative Frequency Response Error

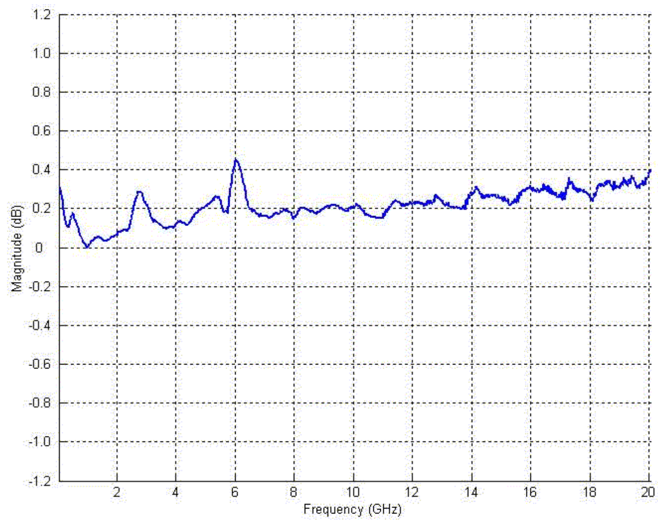


Figure 1-6. E/O Characteristic Peak-to-Peak Repeatability

The above graph shows the worst case deviation across a 20 GHz span between any 2 units in a sample set of 12.

E/O Frequency Response Error for Different Reflection Coefficients

A significant error term in this measurement is the electrical port match of the device under test (DUT). The following table lists the measurement uncertainty as a function of DUT electrical reflection coefficient. If you perform a response and match calibration, you can achieve values comparable to measurements of devices with ρ = < 0.25, as shown in "Relative Frequency Response Performance Data" on page 1-8.

Electrical-to-Optical Relative Frequency Response Versus ρ		
Frequency Range	**ρ < 0.5 Specification**	**ρ < 1.0 Specification**
0.05 to 0.5 GHz	± 1.75	± 3.10
0.5 to 11 GHz	± 2.05	± 3.35
11 to 20.05 GHz	± 2.40	± 3.40

Electrical-to-Optical Measurement Dynamic Range Characteristics

Electrical-to-Optical Measurement Dynamic Range[a]		
Description	**Frequency Range**	**Characteristic**
System Dynamic Range	0.05 to 20.05 GHz	80 dB

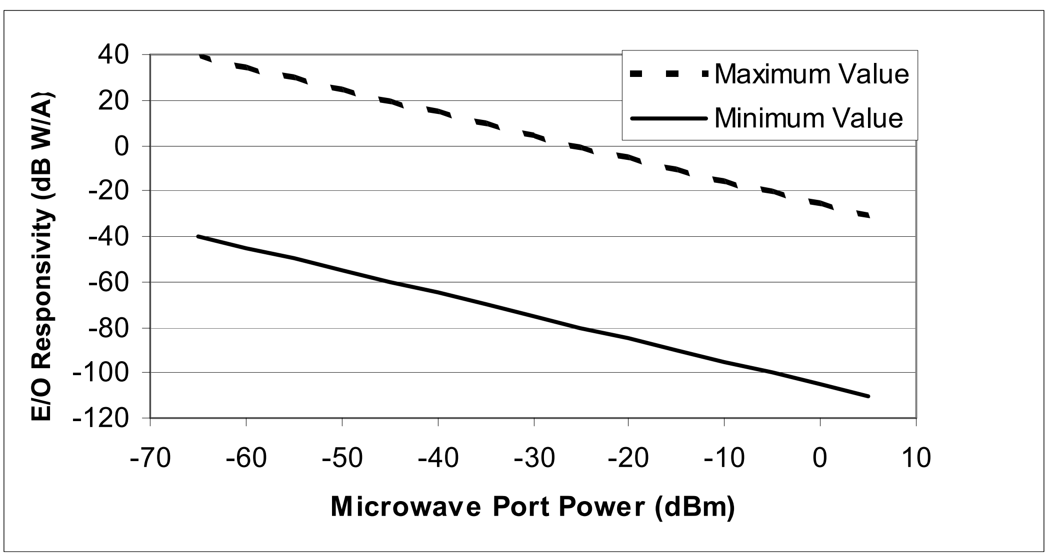
a. Pertains to a 10 Hz IF bandwidth.

Electrical-to-Optical Measurement Responsivity Measurement Range

The following table shows the maximum and minimum values of the E/O device under test (DUT) frequency response, measured with microwave power applied from microwave port 1. The dynamic range stays constant irrespective of the microwave port power. That is, the maximum and the minimum dB W/A that can be measured increase with reduced microwave port power.

Electrical-to-Optical Measurement Responsivity Measurement Range[a]			
Power at Port 1 (dBm)	**Maximum Value (dB W/A) Characterisitc**	**Minimum Value (dB W/A) Characterisitc**	**Dynamic Range (dB) Characterisitc**
5	–30	–110	80
–65	40	–40	80

a. Pertains to a 10 Hz IF bandwidth.



General Information

Table 1-1. General Information

8703B General Information	
Description	**Characteristic**
System Bandwidths	
IF bandwidth settings	6000 Hz 3700 Hz 3000 Hz 1000 Hz 300 Hz 100 Hz 30 Hz 10 Hz
Rear Panel	
External Auxiliary Input	
Connector	Female BNC
Range	±10 V
External Trigger	Triggers on a positive or negative TTL transition or contact closure to ground.
Damage Level	< –0.2 V; > +5.2 V
Limit Test Output	Female BNC.
Damage Level	< –0.2 V; > +5.2 V
Test Sequence Output	Outputs a TTL signal which can be set to a TTL high pulse (default) or low pulse at end of sweep; or a fixed TTL high or low. If limit test is on, the end of sweep pulse occurs after the limit test is valid. This is useful when used in conjunction with test sequencing.
Test Set Interconnect	25-pin-D-sub (DB-25) female; use to connect the lightwave test sets
Measure Restart	Floating closure to restart measurement.
External AM Input	±1 volt into a 5 kΩ resistor, 1 kHz maximum, resulting in approximately 2 dB/volt amplitude modulation.
Frequency	10.0000 MHz
Frequency Stability (0 °C to 55 °C)	±0.05 ppm
Daily aging rate (after 30 days)	$< 3 \times 10^{-9}$/day
Yearly aging rate	±0.5 ppm/year
Ouput	≥0 dBm
Output Impedance	50 Ω

Table 1-2. General Information

General Information		
Description	**Specification**	**Characteristic**
Rear Panel		
Test Port Bias Input		
Maximum voltage	±40 Vdc	
Maximum current	±500 mA	
External Reference In		
Input Frequency	1, 2, 5, and 10 MHz	±200 Hz at 10 MHz
Input Power		–10 dBm to +20 dBm
Input Impedance		50 Ω
VGA Video Output		15-pin mini D-Sub; female. Drives VGA compatible monitors.
GPIB		Type-57, 24-pin; Microribbon female
Parallel Port		25-pin D-Sub (DB-25); female; may be used as printer port or general purpose I.O. port
RS232		9-pin D-Sub (DB-9); male
Mini-DIN Keyboard/Barcode Reader		6-pin mini DIN (PS/2); female
Line Power		A third-wire ground is required.
Frequency for Microwave Test Set	47 Hz to 63 Hz	
Frequency for Lightwave Test Set	50 Hz to 60 Hz	
Voltage at 115 V setting	90 V to 132 V	115 V
Voltage at 230 V setting	198 V to 265 V	230 V
VA Maximum for Microwave Test Set	450 VA max	
VA Maximum for Lightwave Test Set	70W max	
Front Panel		
RF Connector		3.5-mm precision (male)

Table 1-3. General Information

General Information	
Description	**Specification**
Front Panel	
Display Pixel Integrity	
Red, Green, or Blue Pixels	Red, green, or blue "stuck on" pixels may appear against a black background. In a properly working display, the following will not occur: • complete rows or columns of stuck pixels • more than 5 stuck pixels (not to exceed a maximum of 2 red or blue, and 3 green) • 2 or more consecutive stuck pixels • stuck pixels less than 6.5 mm apart
Dark Pixels	Dark "stuck on" pixels may appear against a white background. In a properly working display, the following will not occur: • more than 12 stuck pixels (not to exceed a maximum of 7 red, green, or blue) • more than one occurrence of 2 consecutive stuck pixels • stuck pixels less than 6.5 mm apart

Table 1-4. General Information

General Information		
Description	**Specification**	**Characteristic**
General Environmental		
RFI/EMI Susceptibility		Defined by CISPR Pub. 11 and FCC Class B standards.
ESD		Minimize using static-safe work procedures and an antistatic bench mat (part number 9300-0797).
Dust		Minimize for optimum reliability.
Operating Environment		
Temperature	+20 °C to +30 °C	Instrument powers up, phase locks, and displays no error messages within this temperature range.
Humidity	5% to 95% at +30 °C (non-condensing)	
Altitude	0 to 4.5 km (15,000 ft)	
Storage Conditions		
Temperature	–40 ×°C to +55 °C	
Humidity	5% to 95% RH at +40 °C (non-condensing)	
Altitude	0 to 15.24 km (50,000 ft)	
Cabinet Dimensions		
Height x Width x Depth		(323 x 430x 476 mm) (12.71 x 16.93 x 18.74 inches) Cabinet dimensions exclude front and rear protrusions.
Weight		
Shipping Net		151 lb 76 lb
Internal Memory - Data Retention Time with 3 V, 1.2 Ah Battery[a]		
70 °C		250 days (0.68 year)
40 °C		1244 days (3.4 years)
25 °C		10 years

a. Analyzer power is switched off.

Laser Safety Considerations

Laser radiation in the ultraviolet and far infrared parts of the spectrum can cause damage primarily to the cornea and lens of the eye. Laser radiation in the visible and near infrared regions of the spectrum can cause damage to the retina of the eye.

The CW laser sources use a laser from which the greatest dangers to exposure are:

1. To the eyes, where aqueous flare, cataract formation, and/or corneal burn are possible.
2. To the skin, where burning is possible.

WARNING **Do NOT, under any circumstances, look into the optical output or any fiber/device attached to the output while the laser is in operation.**

WARNING **Do not enable the laser unless fiber or an equivalent device is attached to the optical output connector.**

This system should be serviced only by authorized personnel.

CAUTION Use of controls or adjustments or performance of procedures other than those specified herein can result in hazardous radiation exposure.

Laser Classifications

United States-FDA Laser Class IIIb. The system is rated USFDA (United States Food and Drug Administration) Laser Class IIIb according to Part 1040, Performance Standards for Light Emitting Products, from the Center for Devices and Radiological Health.

International-IEC Laser Class 3B. The system is rated IEC (International Electrotechnical Commission) Laser Class 3B laser products according to Publication 825.

International-IEC 825-1: 1993-11. The system helps satisfy the International (IEC825) safety requirements with the use of a REMOTE SHUTDOWN and a KEY SWITCH.

Laser Warning Labels

The 8703B is shipped with the following warning labels. For systems used outside of the USA, both laser aperture and laser warning labels will be included with the shipment (The labels are located in the same box as this manual). Place these labels directly over the USA laser warning and aperture labels.

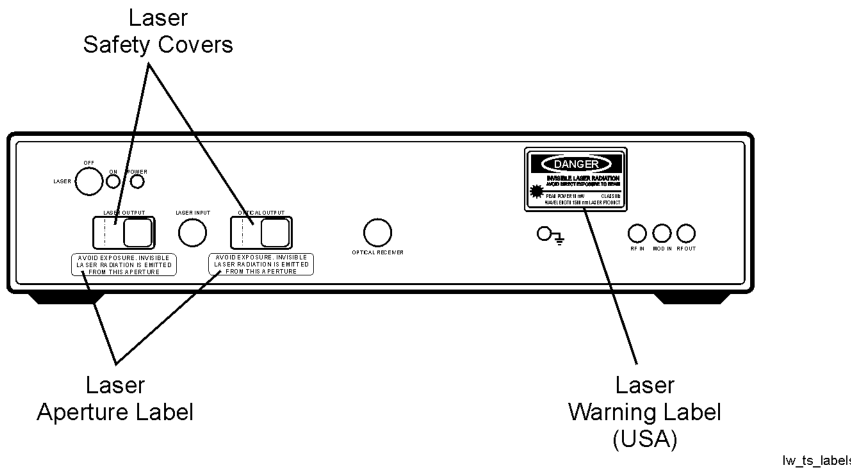


Figure 1-7. Laser safety label locations

CAUTION Exposure to temperatures above 55°C may cause the front panel fiber to retract. In this case a matching compound can be used to temporarily improve return loss. However, the system should be returned to Agilent Technologies for repair.

CAUTION This product is designed for use in INSTALLATION CATEGORY II and POLLUTION DEGREE 2, per IEC 1010 and 664 respectively.

Declaration of Conformity

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

Manufacturer's Name: Agilent Technologies, Inc.

Manufacturer's Address: 1400 Fountaingrove Parkway
Santa Rosa, CA 95403-1799
USA

Declares that the product:

Product Name: Lightwave Component Analyzer

Model Number: 8703B

Product Options: This declaration covers all options of the above product.

Is in conformity with:

Safety: IEC 61010-1:1990 +A1:1992+A2:1995 / EN 61010-1:1994+A2:1995
CAN/CSA-C22.2 No. 1010.1-92
IEC 60825-1:1998

EMC: CISPR 11:1990/EN 55011:1991 Group 1, Class A
IEC 61000-4-2:1995+A1:1998 / EN 61000-4-2:1995, 4 kV CD, 8 kV AD
IEC 61000-4-3:1995 / EN 61000-4-3:1995, 3 V/m, 80-1000 MHz
IEC 61000-4-4:1995 / EN 61000-4-4:1995, 0.5 kV sig. lines, 1 kV pow. lines
IEC 61000-4-5:1995 / EN 61000-4-5:1995, 0.5 kV l-l, 1 kV l-e
IEC 61000-4-6:1996 / EN 61000-4-6:1996, 3V 80% AM, power line
IEC 61000-4-11:1994 / EN 61000-4-11:1994, 100 %, 20 ms

Supplementary Information:
The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE-marking accordingly.

Santa Rosa, CA, USA 29 May 2001

Greg Pfeiffer/Quality Engineering Manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor.

Regulatory Information

- This product is classified as Class I according to 21 CFR 1040.10 and Class I according to IEC 60825-1.
- This product complies with 21 CFR 1040.10 and 21 CFR 1040.11.
- This is to declare that this system is in conformance with the German Regulation on Noise Declaration for Machines (Laermangabe nach der Maschinenlaermrerordnung -3.GSGV Deutschland).

Notice for Germany: Noise Declaration

Acoustic Noise Emission	Geraeuschemission
LpA < 70 dB	LpA < 70 dB
Operator position	am Arbeitsplatz
Normal position	normaler Betrieb
per ISO 7779	nach DIN 45635 t.19

COMPLIANCE WITH CANADIAN EMC REQUIREMENTS

This ISM device complies with Canadian ICES-001.

Cet appareil ISM est conforme a la norme NMB du Canada.

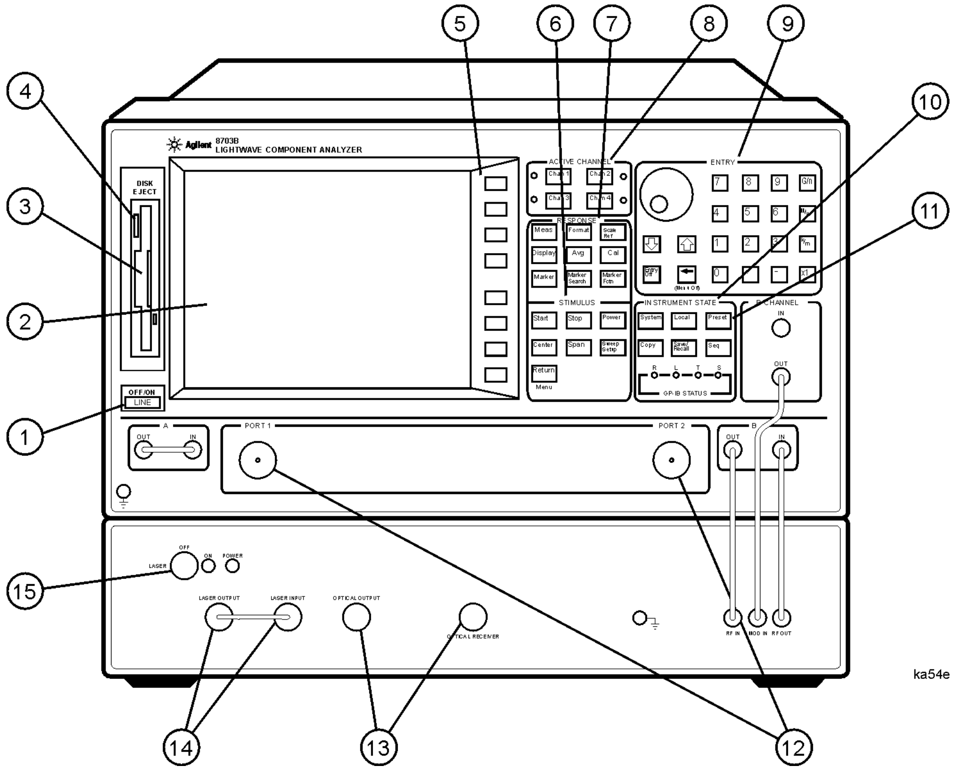
2

Front/Rear Panel

Front Panel Features

CAUTION Do not mistake the line switch for the disk eject button. See the following illustrations. If the line switch is mistakenly pushed, the instrument will be turned off, losing all settings and data that have not been saved.

Figure 2-1. 8703B Front Panel



The location of the following front panel features and key function blocks is shown in Figure 2-1 and Figure 2-2. These features are described in more detail later in this chapter, and in Chapter 4, “Hardkey and Softkey Reference”

1. 1. LINE switch. The front panel LINE switch disconnects the mains circuits from the mains supply after the EMC filters and before other parts of the instrument. 1 is on, 0 is off.
2. Display. This shows the measurement data traces, measurement annotation, and softkey labels. The display is divided into specific information areas, illustrated in Figure 2-2 on page 2-4.
3. Disk drive. This 3.5 inch floppy-disk drive allows you to store and recall instrument states and measurement results for later analysis.
4. Disk eject button.
5. Softkeys. These keys provide access to menus that are shown on the display.
6. STIMULUS function block. The keys in this block allow you to control the analyzer source's frequency, power, and other stimulus functions.
7. RESPONSE function block. The keys in this block allow you to control the measurement and display

functions of the active display channel.

8. ACTIVE CHANNEL keys. The analyzer has two independent primary channels and two auxiliary channels. These keys allow you to select the active channel. Any function you enter applies to the selected channel.
9. The ENTRY block. This block includes the knob, the step **up** and **down** keys, the number pad, and the backspace key. These allow you to enter numerical data and control the markers.

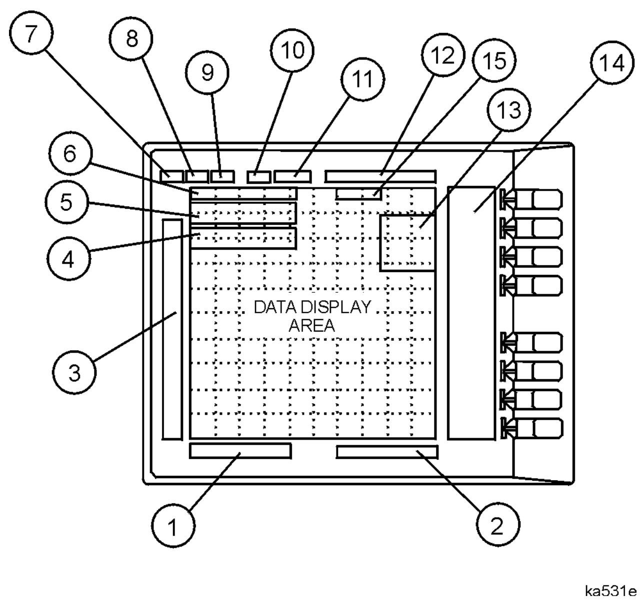
You can use the numeric keypad to select digits, decimal points, and a minus sign for numerical entries. You must also select a units terminator to complete value inputs.

The backspace key has two independent functions: it modifies entries, and it turns off the softkey menu so that marker information can be moved off of the grids and into the softkey menu area. For more details, refer to the "Making Measurements" chapter in the user's guide.

10. INSTRUMENT STATE function block. These keys allow you to control channel-independent system functions such as the following:
    - copying, save/recall, and GPIB controller mode
    - limit testing
    - tuned receiver mode
    - test sequence function
    - GPIB STATUS indicators are also included in this block.
11. **Preset** key. This key returns the instrument to either a known factory preset state, or a user preset state that can be defined. Refer to Chapter 8, "Preset State and Memory Allocation" for a complete listing of the instrument preset condition.
12. PORT 1 and PORT 2. These ports output an RF signal from the source and receive electrical signals from a device under test. The ports provide the stimulus for E/O devices and the receiver O/E devices. PORT 1 allows you to measure S_{12} and S_{11}. PORT 2 allows you to measure S_{21} and S_{22}.
13. OPTICAL OUTPUT and OPTICAL RECEIVER ports. The OPTICAL OUTPUT port emits a lightwave signal from the internal laser and allows you to measure devices that require an optical stimulus. The OPTICAL RECEIVER port receives lightwave input signals from an optical device under test and allows you to measure the device response.
14. LASER OUTPUT and LASER INPUT ports. The LASER OUTPUT port emits a lightwave signal from the internal laser and allows you to modulate a device under test. the LASER INPUT port allows you to use an external laser for 8703B measurements.
15. LASER ON/OFF. The LASER ON switch position allows analyzer internal laser to output a lightwave signal from the OPTICAL OUTPUT port. The LASER OFF switch position shuts down the analyzer internal laser.

Analyzer Display

Figure 2-2. Analyzer Display (Single Channel, Cartesian Format)



The analyzer display shows various measurement information:

- The grid where the analyzer plots the measurement data.
- The currently selected measurement parameters.
- The measurement data traces.

Figure 2-2 illustrates the locations of the different information labels described below. In addition to the full-screen display shown in the illustration above, multi-graticule and multi-channel displays are available, as described in the “Making Measurements” chapter of the user’s guide. Several display formats are available for different measurements, as described under **Format,** in Chapter 4, “Hardkey and Softkey Reference”

1. Stimulus Start Value. This value could be any one of the following:
    - The start frequency of the source in frequency domain measurements.
    - The start time in CW mode (0 seconds) measurements.
    - The lower power value in power sweep.

When the stimulus is in center/span mode, the center stimulus value is shown in this space. The color of the stimulus display reflects the current active channel.

2. Stimulus Stop Value. This value could be any one of the following:
   - The stop frequency of the source in frequency domain measurements.
   - The upper limit of a power sweep.

When the stimulus is in center/span mode, the span is shown in this space. The stimulus values can be blanked, as described under the **FREQUENCY BLANK,** softkey in Chapter 4, “Hardkey and Softkey Reference”. (For CW time and power sweep measurements, the CW frequency is displayed centered between the start and stop times or power values.)

3. Status Notations. This area shows the current status of various functions for the active channel.

The following notations are used:

AΔ	Previous autobias value is used and autobias is switched on.
Aut	Correct autobias value is used and autobias is switched on.
Avg	Sweep-to-sweep averaging is on. The averaging count is shown immediately below. (See the **Avg,** key in Chapter 4, “Hardkey and Softkey Reference”)
A/W	Units of calibrated O/E measurements.
Cor	Error correction is on. (For error-correction procedures, refer to the “Calibrating for Increased Measurement Accuracy” chapter in the user’s guide. For error correction theory, refer to Chapter 5, “Operating Concepts”.
CΔ	Stimulus parameters have changed from the error-corrected state, or interpolated error correction is on. (For error-correction procedures, refer to the “Calibrating for Increased Measurement Accuracy” chapter in the user’s guide. For error correction theory, refer to Chapter 5, “Operating Concepts”.
C2	Full two-port error-correction is on and the reverse sweep is not updated each sweep. Any one of the following causes the reverse sweep not to be updated each sweep: • the instrument uses a mechanical switch. • different channel power ranges (PORT POWER UNCOUPLED) which puts the test set switch in HOLD mode. • the user manually puts the test set switch in HOLD mode (TESTSET SW 0 or >1).
dBe	Dedicated measurement E/O, O/E, or E/E.
dBo	Optical measurement only (O/O).
Del	Electrical delay has been added or subtracted, or port extensions are active. (See “Operating Concepts” on page 5-1 and the **Scale Ref,** key in Chapter 4, “Hardkey and Softkey Reference”)
ext	Waiting for an external trigger.
Hld	Hold sweep. (See **HOLD,** in Chapter 4, “Hardkey and Softkey Reference”)
man	Waiting for manual trigger.

PC	Power meter calibration is on. (For power meter calibration procedures, refer to the “Calibrating for Increased Measurement Accuracy” chapter of the user’s guide.)
PC?	The analyzer's source could not be set to the desired level, following a power meter calibration. (For power meter calibration procedures, refer to the “Calibrating for Increased Measurement Accuracy” chapter in the user’s guide.)
P?	Source power is unleveled at start or stop of sweep.
P↓	Source power has been automatically set to minimum, due to receiver overload. (See **POWER,** in Chapter 4, “Hardkey and Softkey Reference”)
PRm	Power range is in manual mode.
Smo	Trace smoothing is on. (See AVG and SMOOTHING in Chapter 4, “Hardkey and Softkey Reference”)
tsH	Indicates that the test set hold mode is engaged. That is, a mode of operation is selected which would cause repeated switching of the step attenuator, or a mechanical switch. This hold mode may be overridden. See **MEASURE RESTART,** or **NUMBER OF GROUPS,** in Chapter 4, “Hardkey and Softkey Reference”
W/A	Units of calibrated E/O measurements.
↑	Fast sweep indicator. This symbol is displayed in the status notation block when sweep time is ≤1.0 second. When sweep time is ≥ 1.0 second, this symbol moves along the displayed trace.
*	Source parameters changed: measured data in doubt until a complete fresh sweep has been taken.

4. Active Entry Area. This displays the active function and its current value.
5. Message Area. This displays prompts or error messages.
6. Title. This is a descriptive alphanumeric string title that you define and enter through an attached keyboard or as described in the user’s guide.
7. Active Channel. This is the label for the number for the active channel, selected with the **Chan 1, Chan 2, Chan 3,** and **Chan 4,** keys.

If multiple channels are overlaid, the labels will appear in this area. The active channel is denoted by a rectangle around the channel number.

For multiple-graticule displays, the channel information labels will be in the same relative position for each graticule.

NOTE The label of the active channel is enclosed in a rectangle to differentiate it from inactive channels.

8. Measured Input(s). This shows the parameter, input, or ratio of inputs currently measured, as selected using the **Meas** key. Also indicated in this area is the current display memory status.
9. Format. This is the display format that you selected using the **Format** key.
10. Scale/Div. This is the scale that you selected using the **Scale Ref** key, in units appropriate to the current measurement.
11. Reference Level. This value is the reference line in Cartesian formats or the outer circle in polar

formats, whichever you selected using the **Scale Ref,** key. The reference level is also indicated by a small triangle adjacent to the graticule, at the left for channel 1 and at the right for channel 2 in Cartesian formats.

12. Marker Values. These are the values of the active marker, in units appropriate to the current measurement.
13. Marker Stats, Bandwidth. These are statistical marker values that the analyzer calculates when you access the menus with the **Marker Fctn,** key.

    This general area is also where information for additional markers is placed. Note that Stats and Bandwidth have priority.
14. Softkey Labels. These menu labels redefine the function of the softkeys that are located to the right of the analyzer display.
15. Pass Fail. During limit testing, the result will be annunciated as `PASS` if the limits are not exceeded, and `FAIL` if any points exceed the limits.

Rear Panel Features and Connectors

Figure 2-3. 8703B Rear Panel

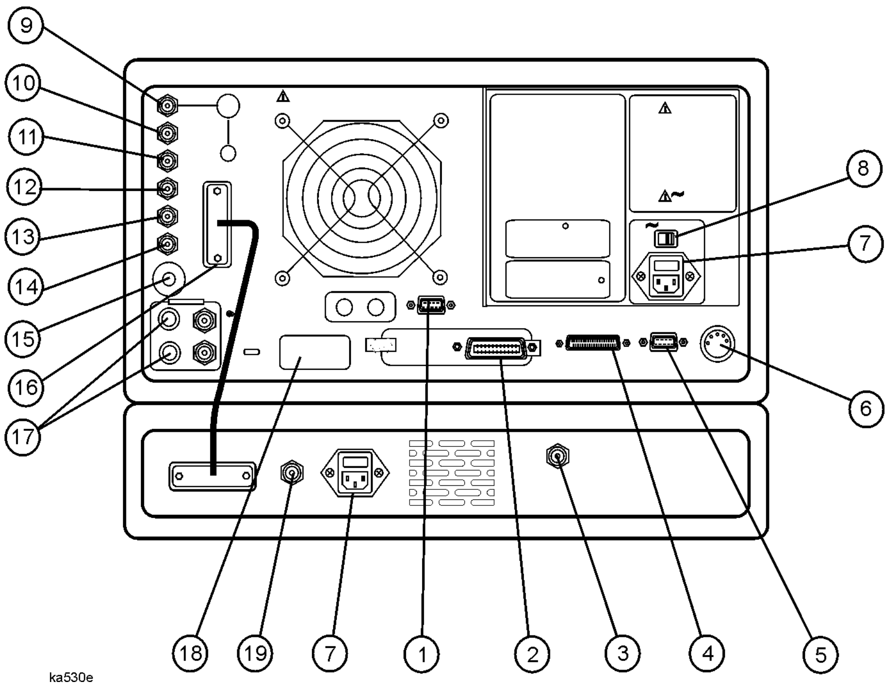


Figure 2-3 illustrates the features and connectors of the rear panel, described below. Requirements for input signals to the rear panel connectors are provided in the specifications and characteristics chapter.

1. EXTERNAL MONITOR: VGA. VGA output connector provides analog red, green, and blue video signals which can drive a VGA monitor.
2. GPIB connector. This allows you to connect the analyzer to an external controller, compatible peripherals, and other instruments for an automated system. Refer to Chapter 7, “Options and Accessories” for GPIB information, limitations, and configurations.
3. EXT ALC INPUT. This connector allows you to input an external signal for the automatic leveling control (ALC).
4. PARALLEL interface. This connector allows the analyzer to output to a peripheral with a parallel input. Also included, is a general purpose input/output (GPIO) bus that can control eight output bits and read five input bits through test sequencing. Refer to Chapter 7, “Options and Accessories” for information on configuring a peripheral. Also refer to “The GPIO Mode” in the “Operating Concepts” chapter of the user’s guide.
5. RS-232 interface. This connector allows the analyzer to output to a peripheral with an RS-232 (serial) input.
6. KEYBOARD input (mini-DIN). This connector allows you to connect an external keyboard. This provides a more convenient means to enter a title for storage files, as well as substitute for the analyzer's front panel keyboard.

7. Power cord receptacle, with fuse. For information on replacing the fuse, refer to the installation and quick start guide.
8. Line voltage selector switch. For more information, refer to the installation guide.
9. EXTERNAL REFERENCE INPUT connector. This allows for a frequency reference signal input that can phase lock the analyzer to an external frequency standard for increased frequency accuracy.

The analyzer automatically enables the external frequency reference feature when a signal is connected to this input. When the signal is removed, the analyzer automatically switches back to its internal frequency reference.

10. AUXILIARY INPUT connector. This allows for a dc or ac voltage input from an external signal source, such as a detector or function generator, which you can then measure, using the S-parameter menu. (You can also use this connector as an analog output in service routines, as described in the service guide.)
11. EXTERNAL AM connector. This allows for an external analog signal input that is applied to the ALC circuitry of the analyzer's source. This input analog signal amplitude modulates the RF output signal.
12. EXTERNAL TRIGGER connector. This allows connection of an external negative-going TTL-compatible signal that will trigger a measurement sweep. The trigger can be set to external through softkey functions.
13. TEST SEQUENCE. This outputs a TTL signal that can be programmed in a test sequence to be high or low, or pulse (10 µseconds) high or low at the end of a sweep for robotic part handler interface.
14. LIMIT TEST. This outputs a TTL signal of the limit test results as follows: Pass: TTL high, Fail: TTL low
15. MEASURE RESTART. This allows the connection of an optional foot switch. Using the foot switch will duplicate the key sequence **Meas, MEASURE RESTART.**
16. TEST SET INTERCONNECT. Connects the lightwave test set to the analyzer.
17. BIAS INPUTS AND FUSES. These connectors bias devices connected to port 1 and port 2. The fuses (1 A, 125 V) protect the port 1 and port 2 bias lines.
18. Serial number plate. The serial number of the instrument is located on this plate.
19. REMOTE SHUTDOWN. This allows you to remotely control whether the laser is on or off: OPEN=Laser ON, SHORT=Laser OFF.

3

Menu Maps

Menu Maps

This chapter provides menu maps of the Agilent 8703B hardkeys and softkeys. The maps show which softkeys are displayed after pressing a front-panel key, and subsequent menus or softkeys associated with each menu path.

Figure 3-1. Avg Menu

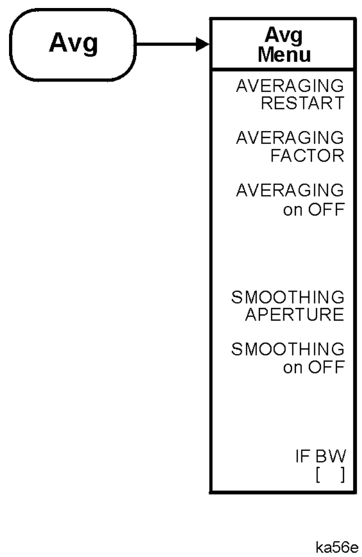
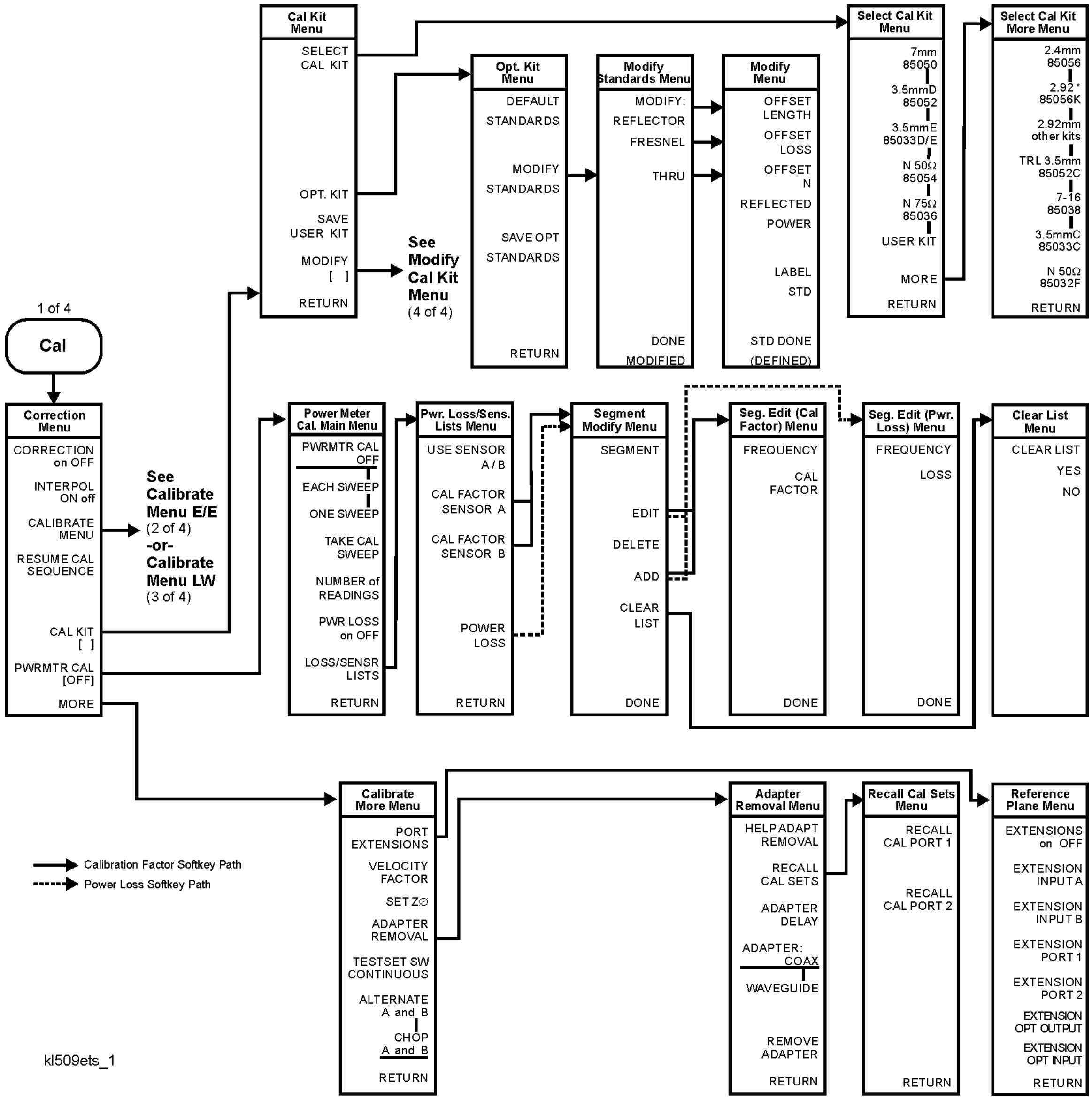


Figure 3-2. Cal Menu (1 of 4)



Menu Maps

Figure 3-3. Cal Menu (2 of 4): Electrical Parameter Measurement Setup

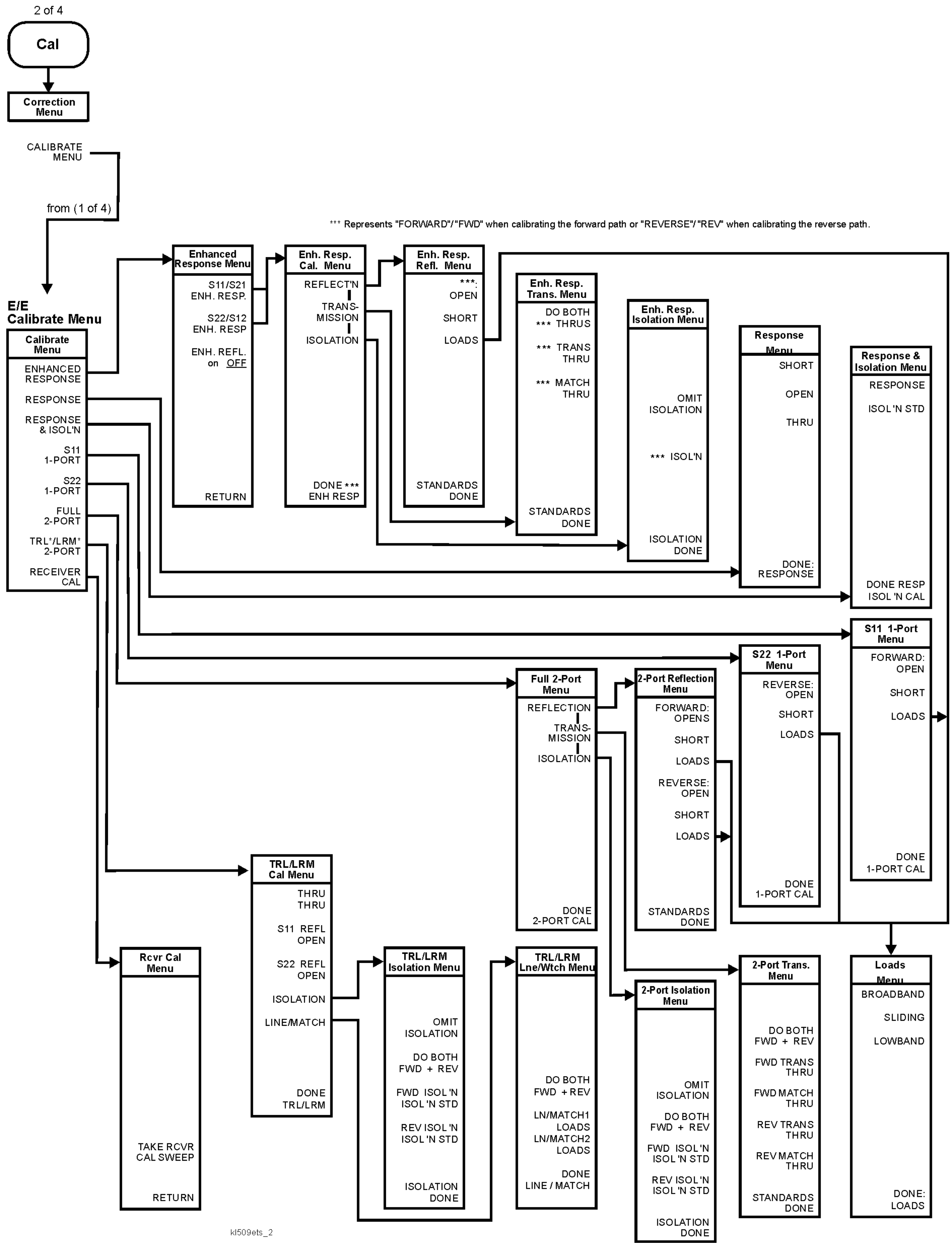
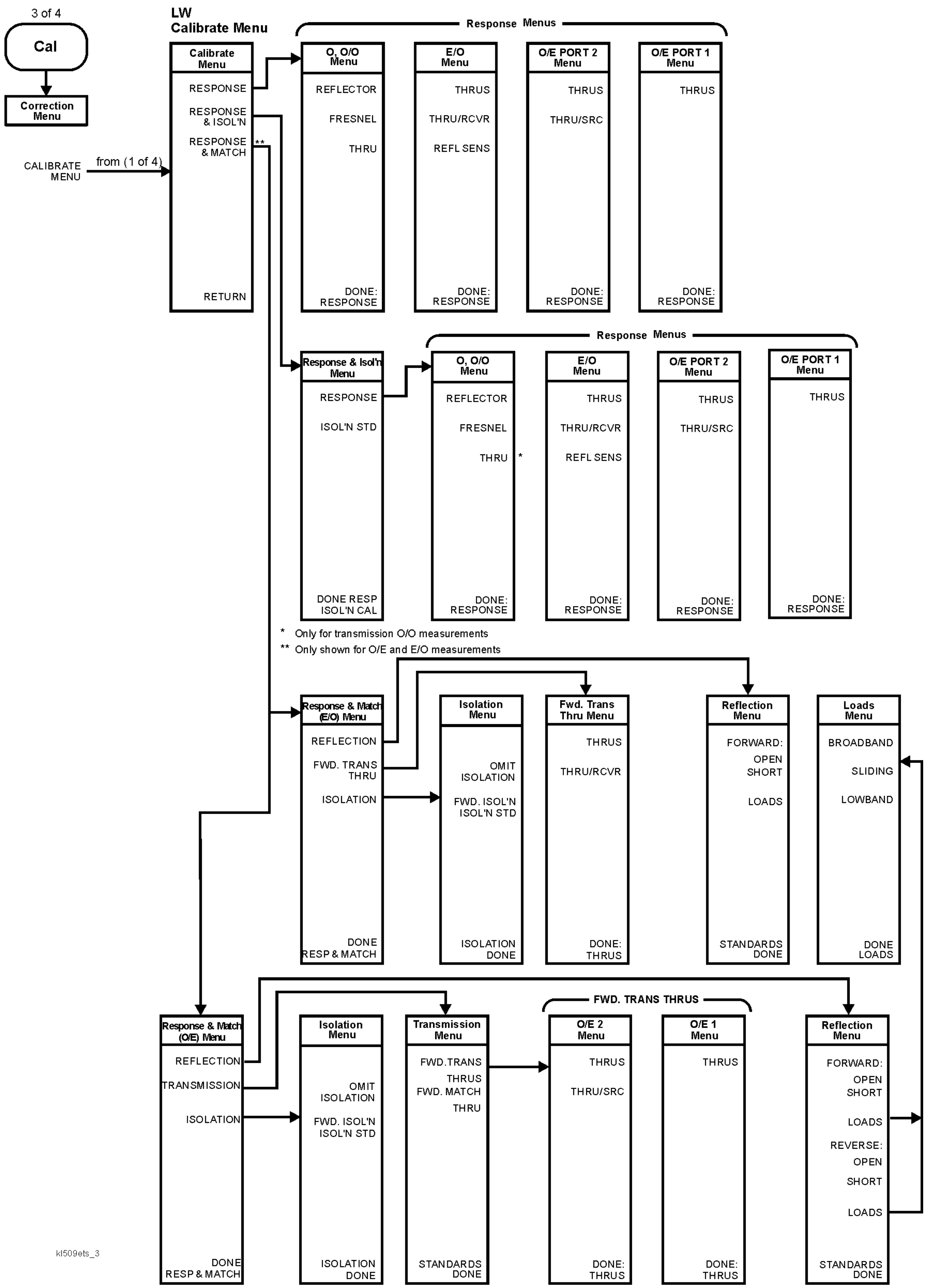
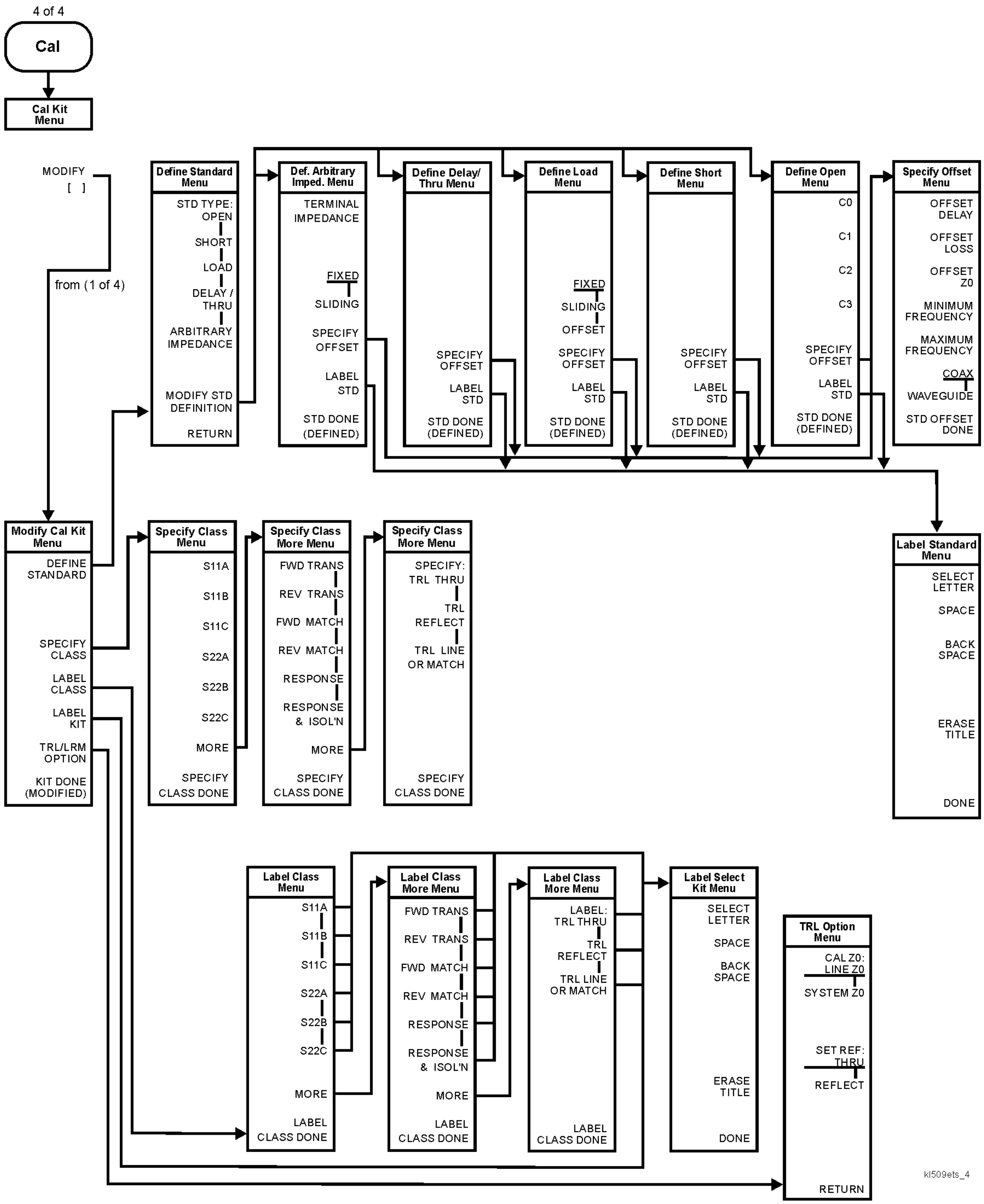


Figure 3-4. Cal Menu (3 of 4): Optical Measurement Setup



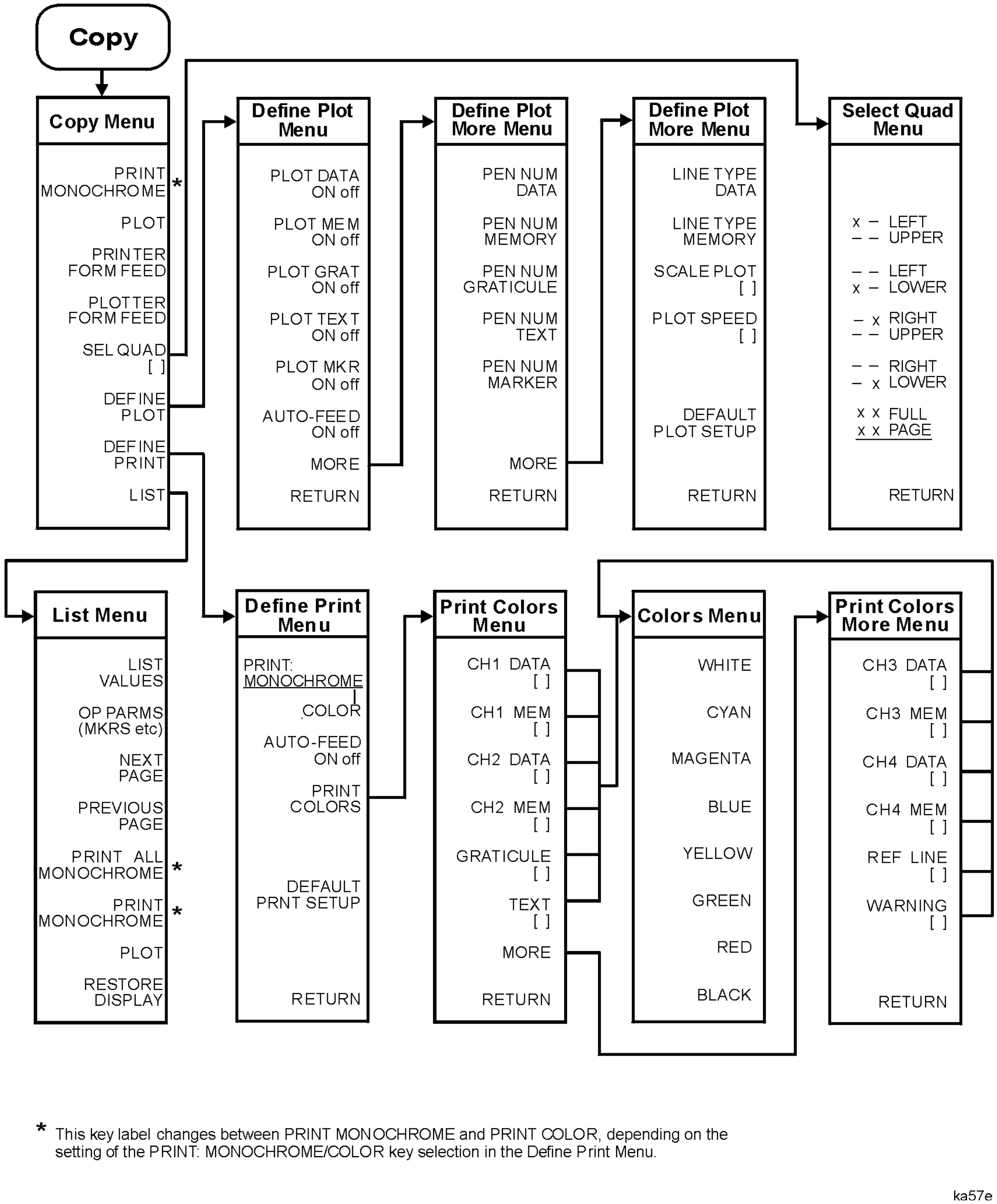
Menu Maps

Figure 3-5. Cal Menu (4 of 4)



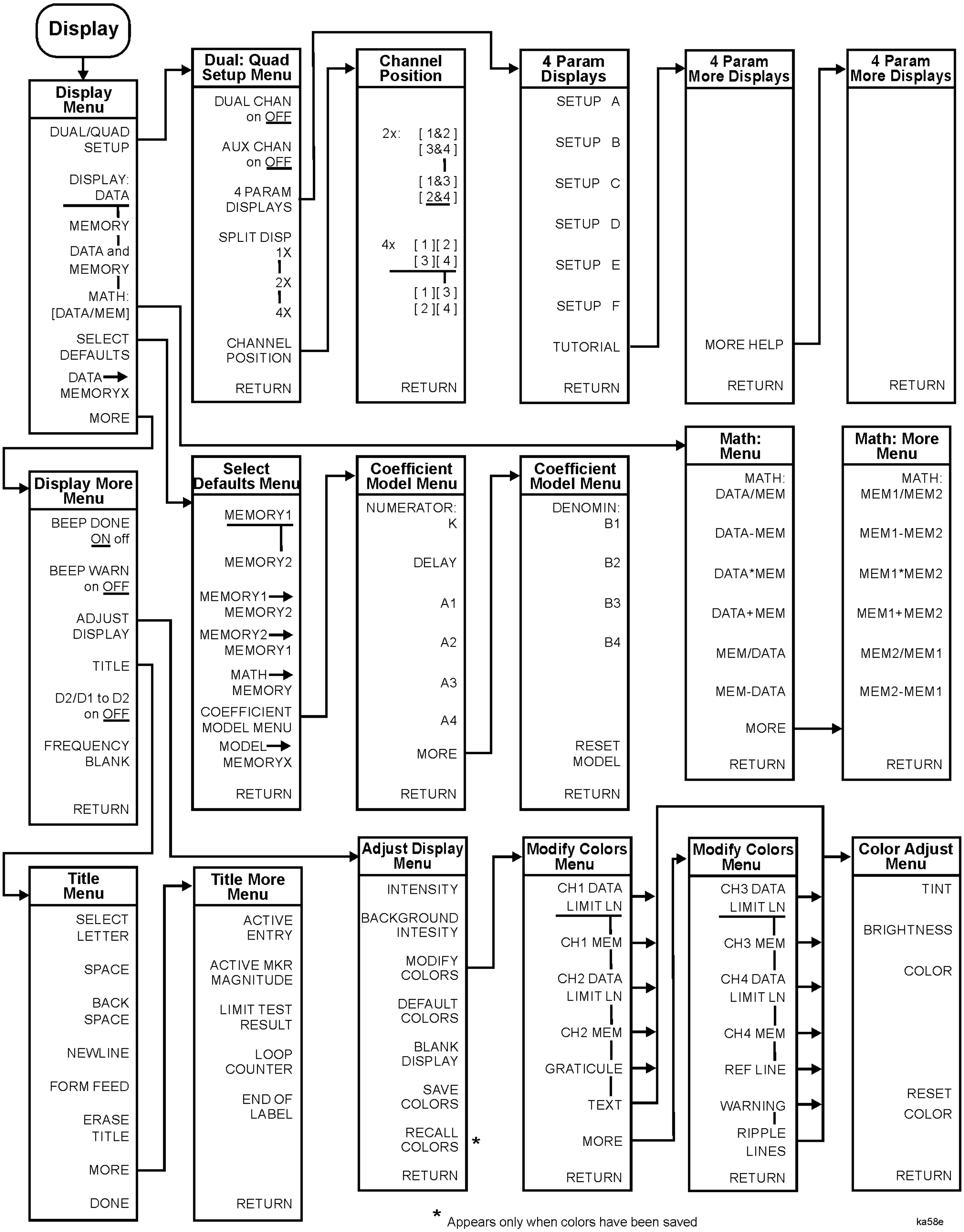
Menu Maps

Figure 3-6. Copy Menu



Menu Maps

Figure 3-7. Display Menu



Menu Maps

Figure 3-8. Format Menu

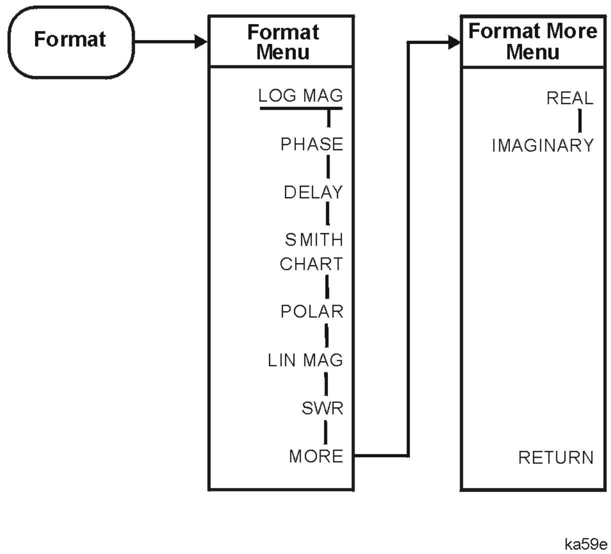


Figure 3-9. Local Menu

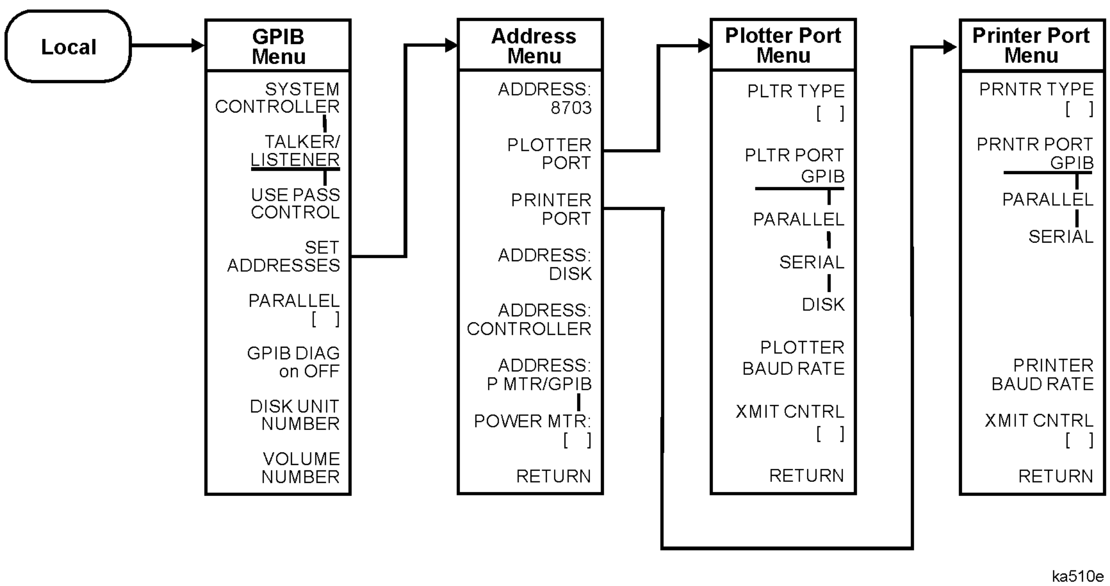
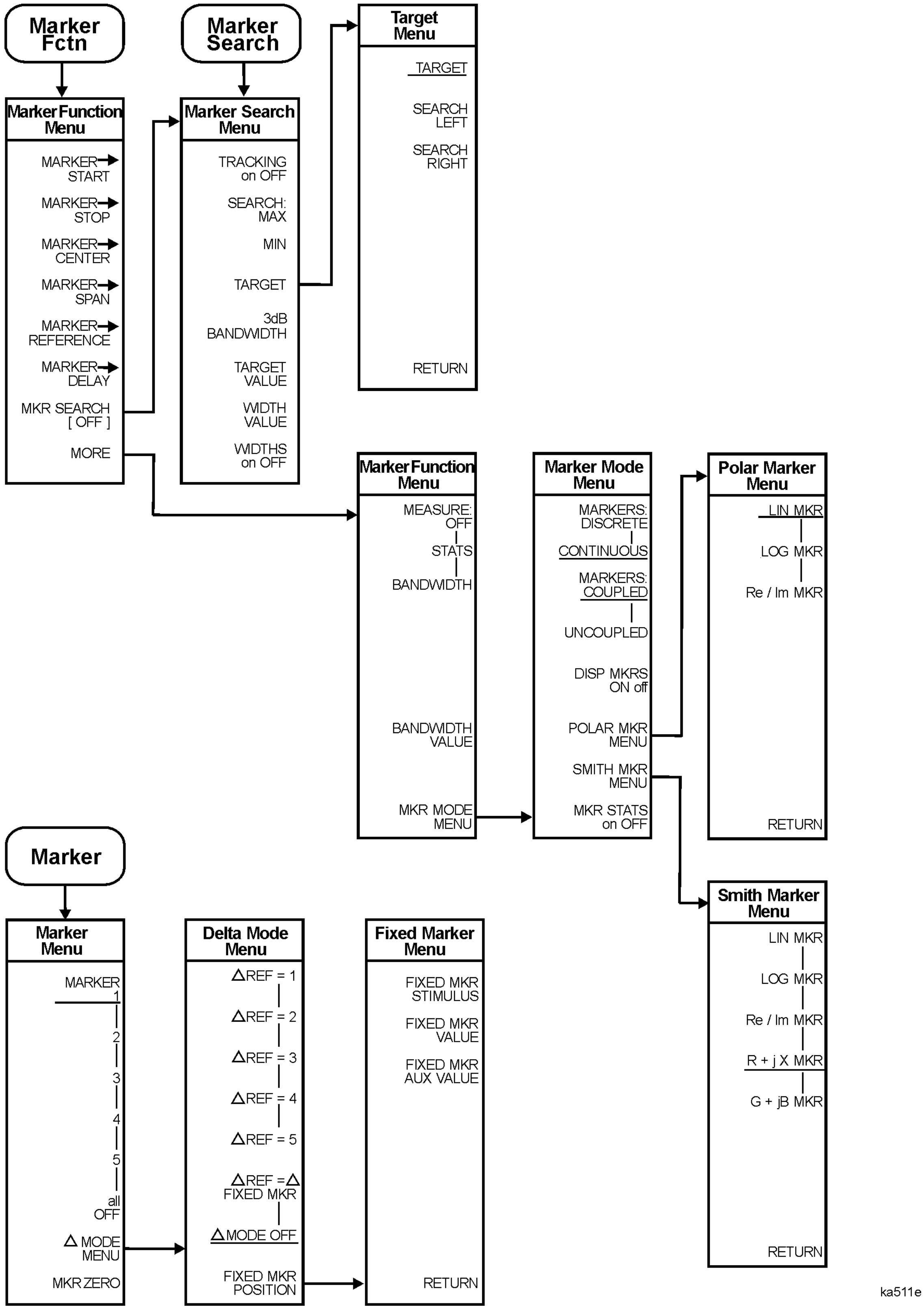
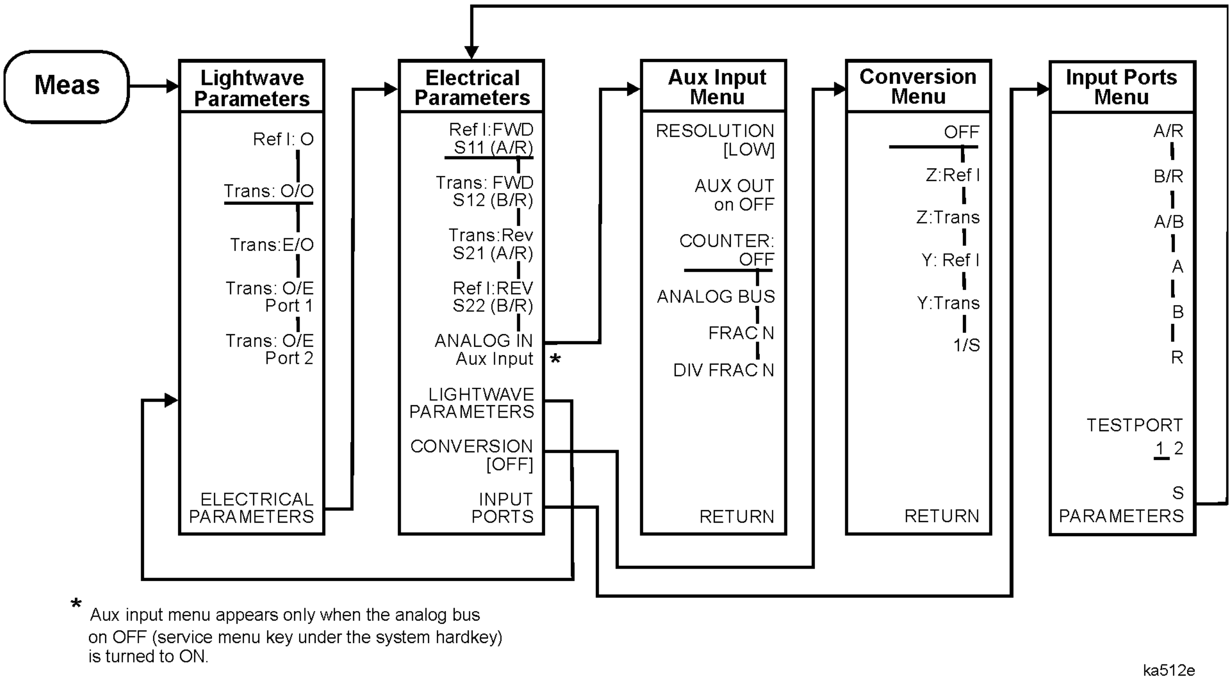


Figure 3-10. Marker, Marker Fctn, and Marker Search Menus



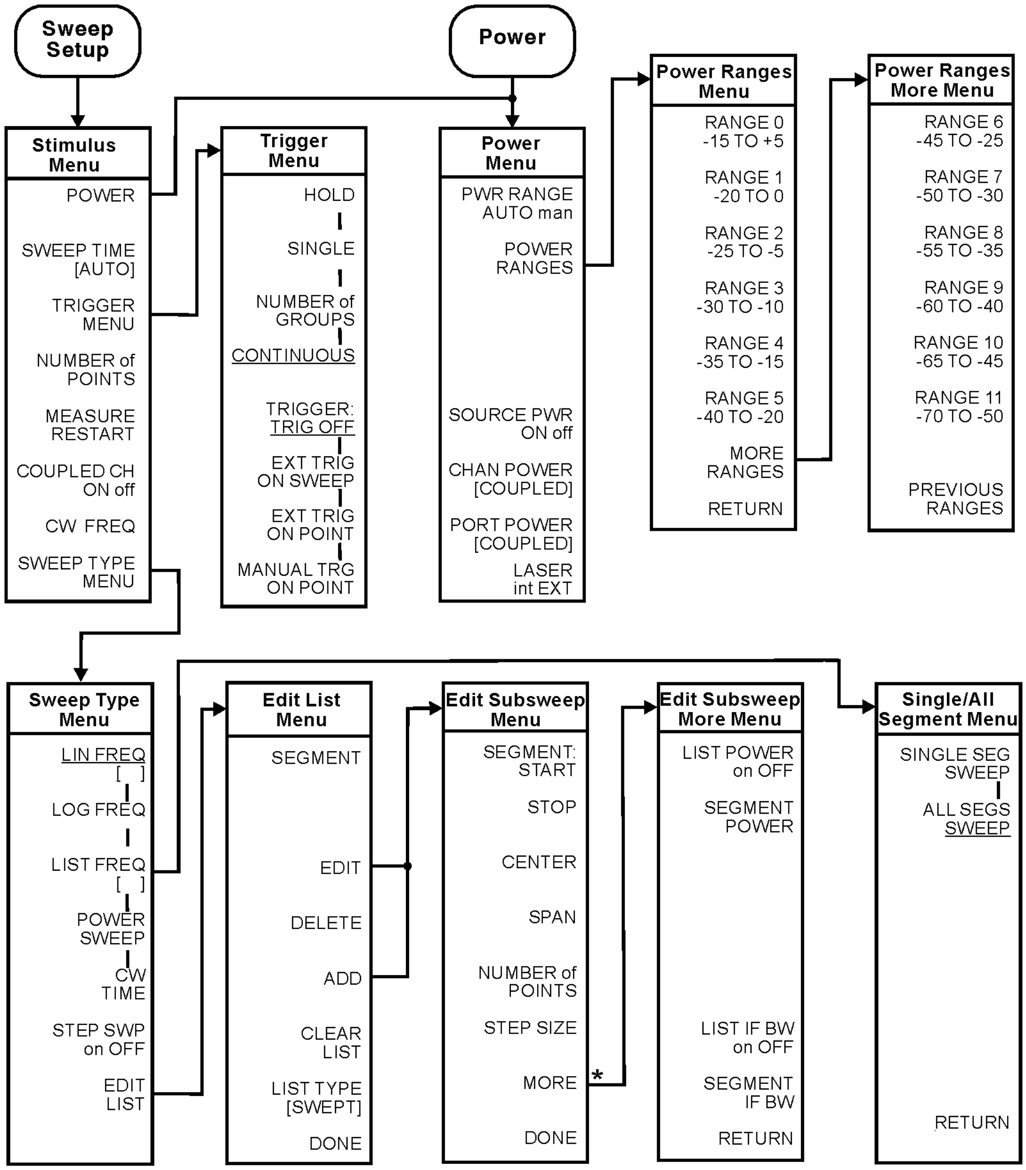
Menu Maps

Figure 3-11. Meas Menu



Menu Maps

Figure 3-12. Power and Sweep Setup Menu



* CW FREQ appears when LIST TYPE [STEPPED] is selected

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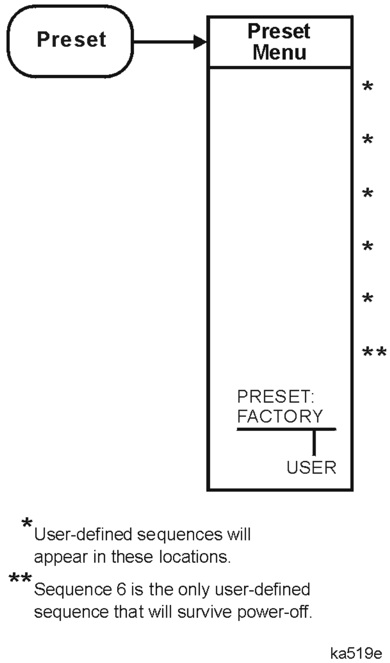
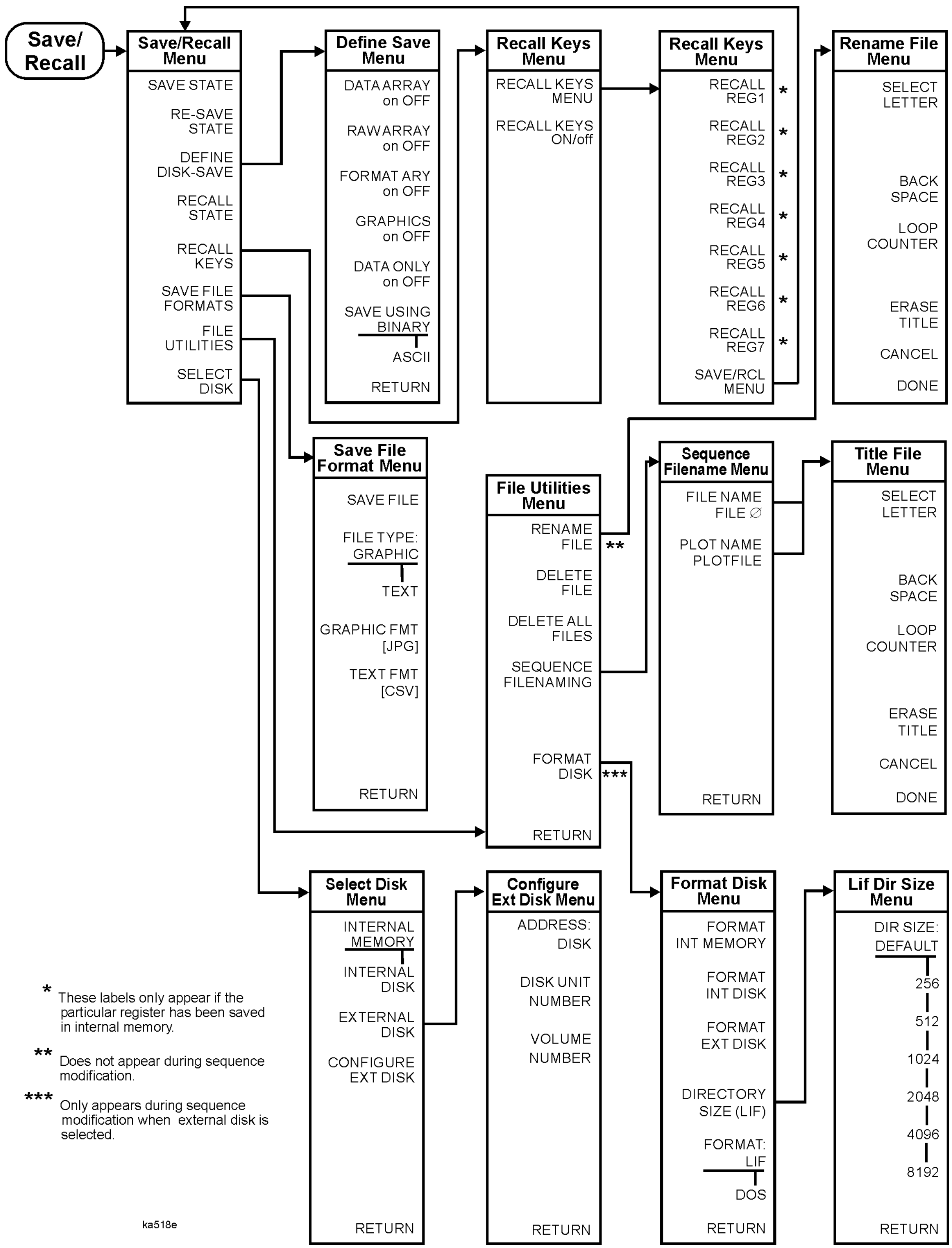
Menu Maps

Figure 3-13. Preset Menu



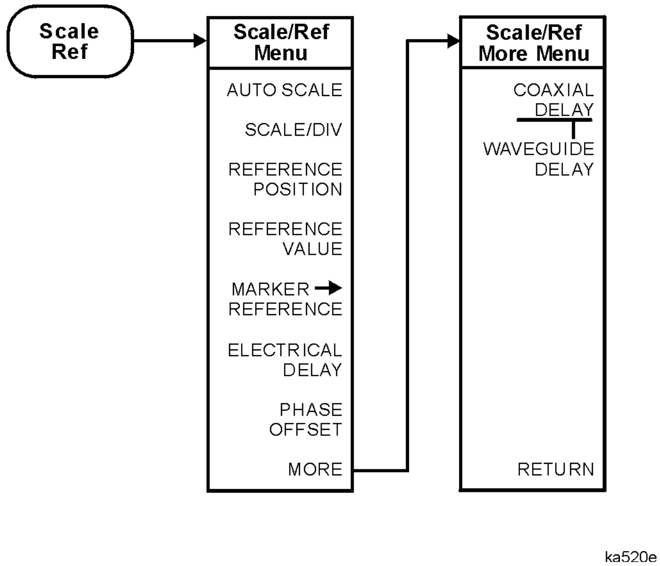
Menu Maps

Figure 3-14. Save/Recall Menu



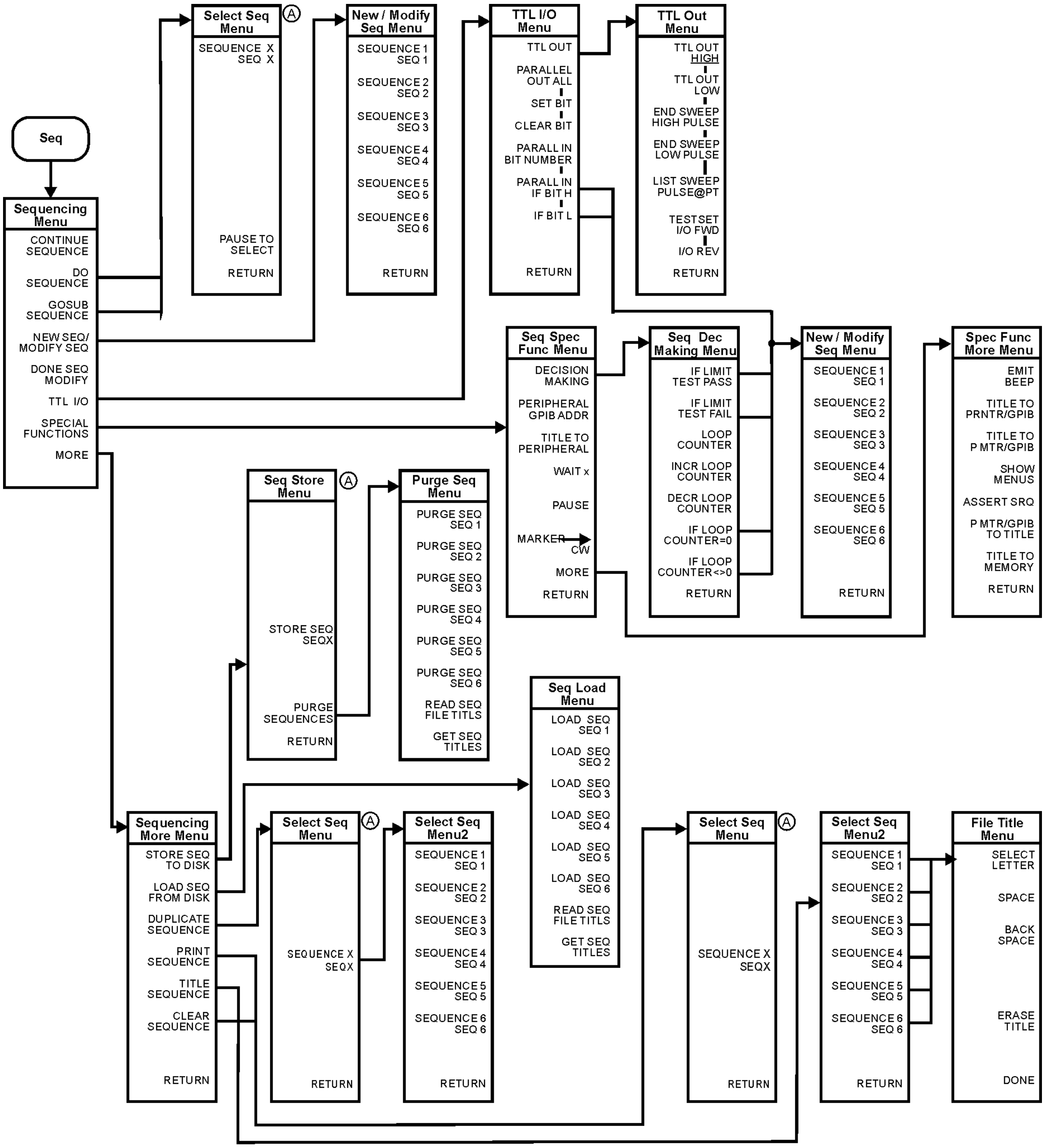
Menu Maps

Figure 3-15. Scale Ref Menu



Menu Maps

Figure 3-16. Seq Menu



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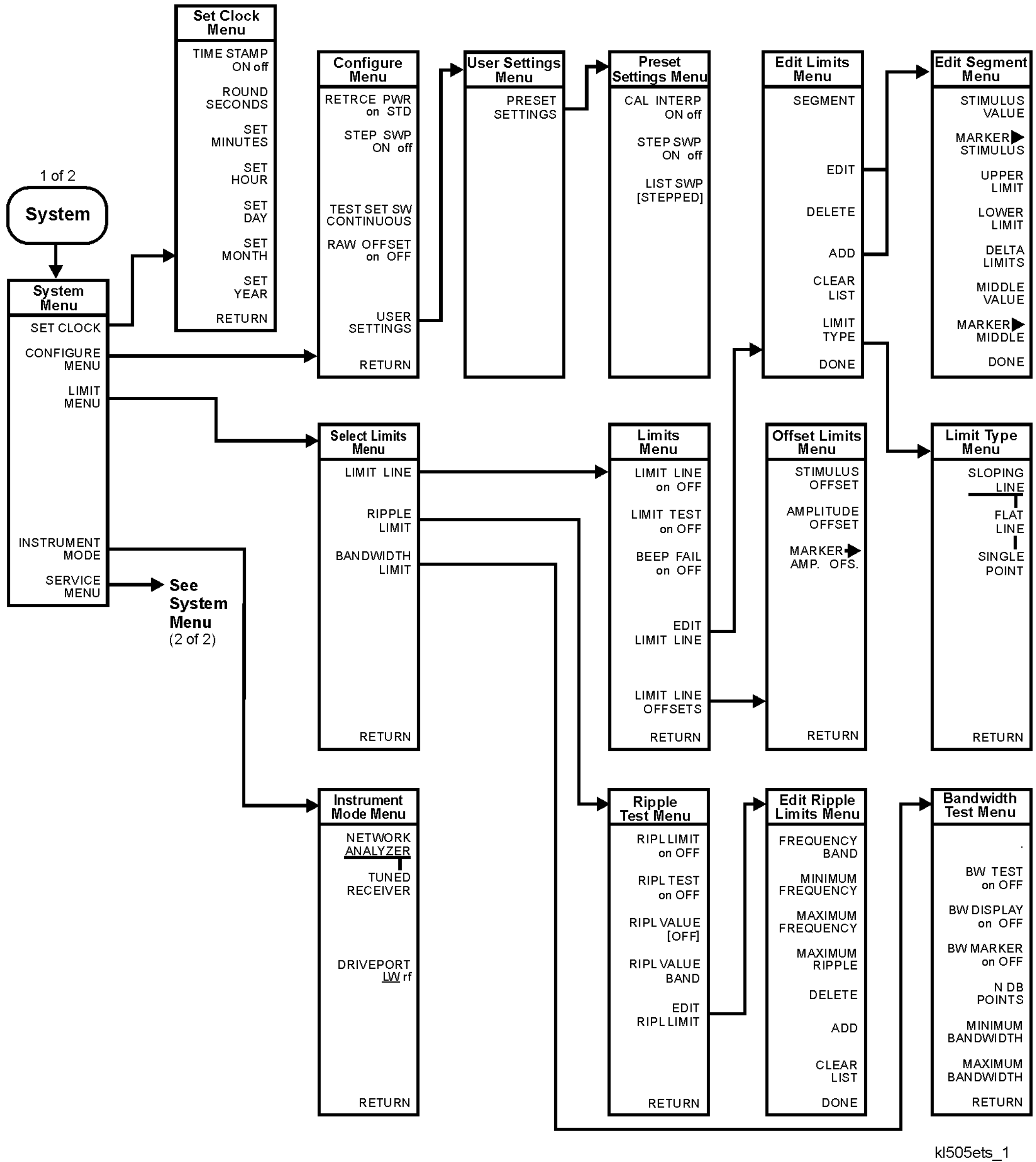
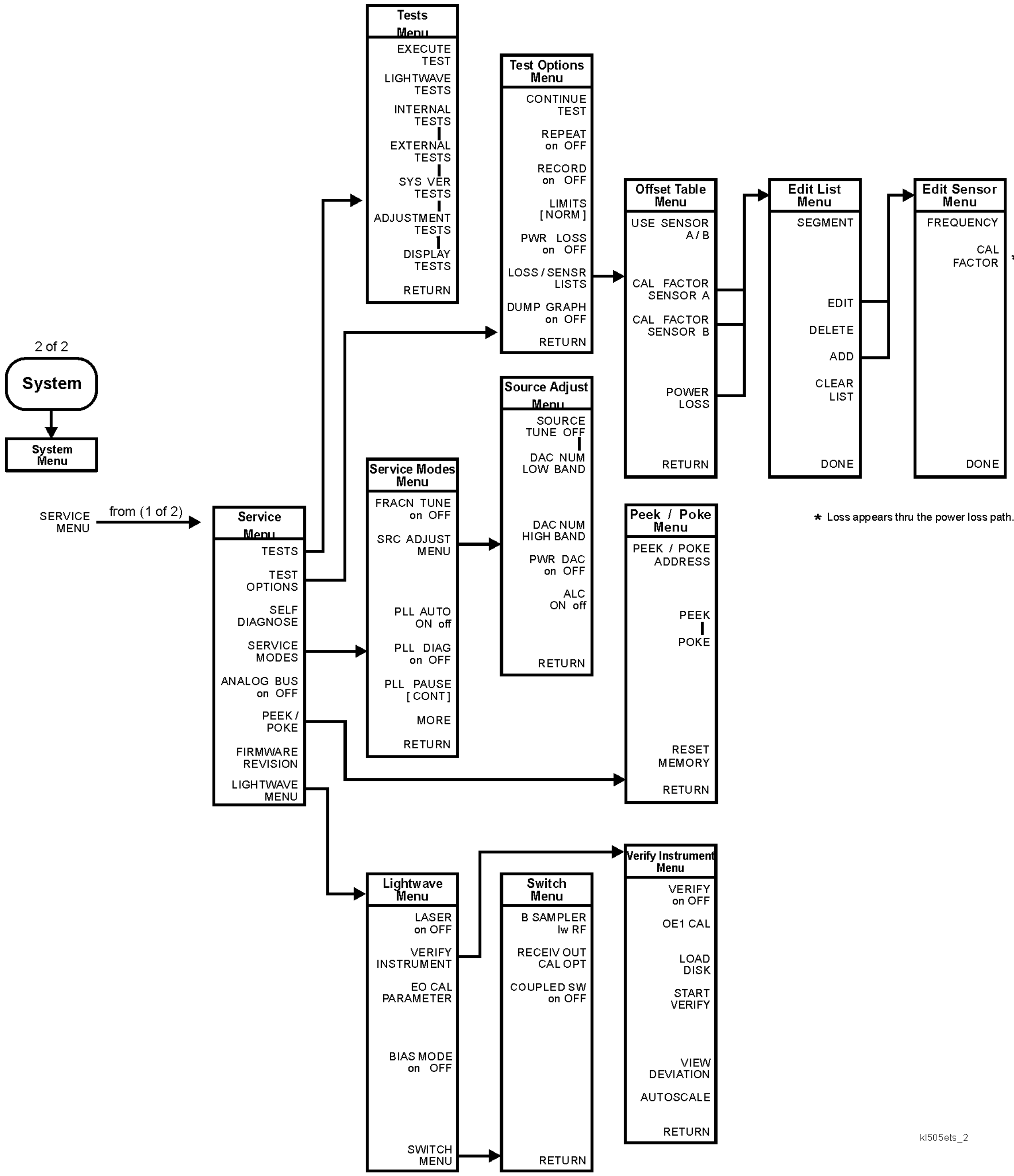
Ⓐ Displays only the user-defined sequence (X), where X is the sequence number, when not modifying a sequence. When modifying a sequence all sequence labels are shown.

Figure 3-17. System Menu (1of 2)



Menu Maps

Figure 3-18. System Menu (2of 2)



4

Hardkey and Softkey Reference

Hardkey and Softkey Reference

This section contains an alphabetical listing of softkey and front-panel functions, and a brief description of each function. The **SERVICE MENU** keys are not included in this chapter.

. is used to add a decimal point to the number you are entering.

– . is used to add a minus sign to the number you are entering.

up. is used to step up the current value of the active function. The analyzer defines the step size for different functions. No units terminator is required. For editing a test sequence, this key can be used to scroll through and execute the displayed sequence one step at a time.

down. is used to step down the current value of the active function. The analyzer defines the step size for different functions. No units terminator is required. For editing a test sequence, this key can be used to scroll backwards through the displayed sequence without executing it.

back. has two independent functions: 1) modifies entries and test sequences and 2) moves marker information off of the graticules

backspace key. will delete the last entry, or the last digit entered from the numeric keypad. The backspace key can also be used in two ways for modifying a test sequence: 1) deleting a single-key command that you may have pressed by mistake, (for example **A/R**) and 2) deleting the last digit in a series of entered digits, as long as you haven't yet pressed a terminator, (for example if you pressed **Start 1 2** but did not press **G/n**, etc.). The second function of this key is to move marker information off of the graticules so that the display traces are clearer. If there are two or more markers activated on a channel on the right side of the display, pressing **back** will turn off the softkey menu and move the marker information into the softkey display area. Pressing **back**, or any hardkey which brings up a menu, or a softkey, will restore the softkey menu and move the marker information back onto the graticules.

Δ MODE MENU. goes to the delta marker menu, which is used to read the difference in values between the active marker and a reference marker.

Δ MODE OFF. turns off the delta marker mode, so that the values displayed for the active marker are absolute values.

Δ REF = 1. establishes marker 1 as a reference. The active marker stimulus and response values are then shown relative to this delta reference. Once marker 1 has been selected as the delta reference, the softkey label **Δ REF = 1** is underlined in this menu, and the marker menu is returned to the screen. In the marker menu, the first key is now labeled **MARKER Δ REF = 1**. The notation "ΔREF=1" appears at the top right corner of the graticule.

Δ REF = 2. makes marker 2 the delta reference. Active marker stimulus and response values are then shown relative to this reference.

Δ REF = 3. makes marker 3 the delta reference.

Δ REF = 4. makes marker 4 the delta reference.

Δ REF = 5. makes marker 5 the delta reference.

Δ REF = Δ FIXED MKR. sets a user-specified fixed reference marker. The stimulus and response values of the reference can be set arbitrarily, and can be anywhere in the display area. Unlike markers 1 to 5, the fixed marker need not be on the trace. The fixed marker is indicated by a small triangle Δ, and the active marker stimulus and response values are shown relative to this point. The notation "ΔREF=Δ" is displayed at the top right corner of the graticule. Pressing this softkey turns on the fixed marker. Its stimulus and response values can then be changed using the fixed marker menu, which is accessed with the **FIXED MKR POSITION** softkey described below. Alternatively, the fixed marker can be set to the current active marker position, using the **MKR ZERO** softkey in the marker menu.

1/S. expresses the data in inverse S-parameter values, for use in amplifier and oscillator design.

2X: [12]/[34]. sets up a two-graticule display with channel 1 and 2 on the top graticule and channels 3 and 4 in the bottom graticule.

2X: [13]/[24]. sets up a two-graticule display with channel 1 and 3 in the top graticule and channels 2 and 4 in the bottom graticule.

2.4mm 85056. selects the 85056A or the 85056D cal kit.

2.92* 85056K. selects the 85056K cal kit.

2.92mm other kits. selects the 2.92 mm cal kit model.

3 DB Bandwidth. searches for the 3 dB bandwidth to the high side of marker 1, the reference marker. This search is intended for low-pass devices.

3.5mm C 85033C. selects the 85033C cal kit.

3.5mm D 85052. selects the 85052B or the 85052D cal kit.

3.5mm E 85033D/E. selects the 85033D or the 85033E cal kit.

4X: [1] [2]/[3] [4]. sets up a four-graticule display with channel 2 in the upper right quadrant and channel 3 in the lower left quadrant.

4X: [1] [3]/[2] [4]. sets up a four-graticule display with channel 3 in the upper right quadrant and channel 2 in the lower left quadrant.

4 PARAM DISPLAYS. provides single-keystroke options to quickly set up multiple-channel displays, and information on multiple-channel displays.

7-16 85038. selects the 85038A/F/M cal kit.

7mm 85050. selects the 85050B/D cal kit.

A. measures the absolute power amplitude at input A.

A/B. calculates and displays the complex ratio of input A to input B.

A/R. calculates and displays the complex ratio of the signal at input A to the reference signal at input R.

ACTIVE ENTRY. puts the name of the active entry in the display title.

ACTIVE MRK MAGNITUDE. puts the active marker magnitude in the display title.

ADAPTER: COAX. selects coaxial as the type of adapter used in adapter removal calibration.

ADAPTER: WAVEGUIDE. selects waveguide as the type of adapter used in adapter removal calibration.

ADAPTER DELAY. is used to enter the value of electrical delay of the adapter used in adapter removal calibration.

ADAPTER REMOVAL. provides access to the adapter removal menu.

ADD. 1) displays the edit segment menu and adds a new segment to the end of the list. The new segment is initially a duplicate of the segment indicated by the pointer > and selected with the **SEGMENT** softkey.
2) adds a new frequency band to the Ripple Limit list which is indicated by the pointer >. The new frequency band is a duplicate of the most recently selected frequency band.

ADDRESS: 8703. sets the GPIB address of the analyzer, using the entry controls. There is no physical address switch to set in the analyzer. The default GPIB address is 16.

ADDRESS: CONTROLLER. sets the GPIB address the analyzer will use to communicate with the external controller.

ADDRESS: DISK. sets the GPIB address the analyzer will use to communicate with an external GPIB disk drive.

ADDRESS: P MTR/GPIB. sets the GPIB address the analyzer will use to communicate with the power meter used in service routines.

ADJUST DISPLAY. presents a menu for adjusting display intensity, colors, and accessing save and recall functions for modified LCD color sets.

ALL SEGS SWEEP. retrieves the full frequency list sweep.

ALC ON off. turns the source ALC off, sets the power to maximum. May cause a test port overload message.

ALTERNATE A and B. measures only one input, A or B, per frequency sweep, in order to reduce spurious signals. Thus, this mode optimizes the dynamic range for all measurements.

AMPLITUDE OFFSET. adds or subtracts an offset in amplitude value. This allows limits already defined to be used for testing at a different response level. For example, if attenuation is added to or removed from a test setup, the limits can be offset an equal amount. Use the entry block controls to specify the offset.

ANALOG IN Aux Input. displays a dc or low frequency ac auxiliary voltage on the vertical axis, using the real format. An external signal source such as a detector or function generator can be connected to the rear panel AUXILIARY INPUT connector.

ARBITRARY IMPEDANCE. defines the standard type to be a load, but with an arbitrary impedance (different from system Z0).

ASSERT SRQ. sets the sequence bit in the Event Status Register, which can be used to generate an SRQ (service request) to the system controller.

AUTO FEED ON off. turns the plotter auto feed function on or off when in the define plot menu. It turns the printer auto feed on or off when in the define print menu.

AUTO SCALE. brings the trace data in view on the display with one keystroke. Stimulus values are not affected, only scale and reference values. The analyzer determines the smallest possible scale factor that will put all displayed data onto 80% of the vertical graticule. The reference value is chosen to put the trace in center screen, then rounded to an integer multiple of the scale factor.

AUX CHAN on OFF. enables and disables auxiliary channels 3 and 4.

AUX OUT on OFF. allows you to monitor the analog bus nodes (except nodes 1, 2, 3, 4, 9, 10, and 12) with external equipment. To do this, connect the equipment to the AUX INPUT BNC connector on the rear panel.

AVERAGING FACTOR. makes averaging factor the active function. Any value up to 999 can be used. The algorithm used for averaging is:

$$A(n) = [S(n) + S(n-1) + \ldots + S(n-F+1)]/F$$

where
A(n) = current average
S(n) = current measurement
F = average factor

AVERAGING on OFF. turns the averaging function on or off for the active channel. “Avg” is displayed in the status notations area at the left of the display, together with the sweep count for the averaging factor, when averaging is on. The sweep count for averaging is reset to 1 whenever an instrument state change affecting the measured data is made. At the start of the averaging or following **AVERAGING RESTART**, averaging starts at 1 and averages each new sweep into the trace until it reaches the specified averaging factor. The sweep count is displayed in the status notations area below “Avg” and updated every sweep as it increments. When the specified averaging factor is reached, the trace data continues to be updated, weighted by that averaging factor.

AVERAGING RESTART. averaging starts at 1 and averages each new sweep into the trace until it reaches the specified averaging factor. The sweep count is displayed in the status notations area below “Avg” and updated every sweep as it increments.

Avg. is used to access three different noise reduction techniques: sweep-to-sweep averaging, display smoothing, and variable IF bandwidth. Any or all of these can be used simultaneously. Averaging and smoothing can be set independently for each channel, and the IF bandwidth can be set independently if the stimulus is uncoupled.

B. measures the absolute power amplitude at input B.

B/R. calculates and displays the complex ratio of input B to input R.

B SAMPLER lw/RF. manually sets the RF switch in the lightwave test set, which feeds directly to the B sampler. The switch toggles between the OPTICAL RECEIVER INPUT port of the lightwave test set and the electrical PORT 2 of the instrument. If COUPLED SW is set to ON, the B SAMPLER setting will revert back to the default position at the end of the sweep.

BACK SPACE. deletes the last character entered.

BACKGROUND INTENSITY. sets the background intensity of the LCD as a percent of white. The factory-set default value is stored in non-volatile memory.

BANDWIDTH. in the Marker Search menu, this key turns on the search for the 3 dB bandwidth point on the high side of the reference marker. You must first place the reference marker (marker 1), and then press BANDWIDTH . This search is intended for lowpass devices. In the Marker Function menu, this key turns on the bandwidth search feature and calculates the center stimulus value, bandwidth, and Q of a bandpass or band-reject shape on the trace. This search is intended for bandpass devices.

BANDWIDTH LIMIT. selects the bandwidth limit line choice. This selection leads to the menu used to define and test bandwidth limits of a bandpass filter.

BANDWIDTH VALUE. sets the magnitude value that defines the passband or rejectband of **BANDWIDTH**.

BEEP DONE ON off. toggles an annunciator which sounds to indicate completion of certain operations such as calibration or instrument state save.

BEEP FAIL on OFF. turns the limit fail beeper on or off. When limit testing is on and the fail beeper is on, a beep is sounded each time a limit test is performed and a failure detected. The limit fail beeper is independent of the warning beeper and the operation complete beeper.

BEEP WARN on OFF. toggles the warning annunciator. When the annunciator is on it sounds a warning when a cautionary message is displayed.

BIAS MODE on OFF. when this mode is ON, the analyzer automatically performs periodic biasing of the modulator in the optical test set.

BLANK DISPLAY. switches off the analyzer's display. This feature may be helpful in prolonging the life of the LCD in applications where the analyzer is left unattended (such as in an automated test system). Pressing any front panel key will restore the default display operation.

BRIGHTNESS. adjusts the brightness of the color being modified. Refer to the user's guide for an explanation of using this softkey for color modification of display attributes.

BW DISPLAY on OFF. displays the measured bandwidth value to the right of the pass/fail message.

BW MARKER on OFF. displays the cutoff frequencies of the bandwidth using markers on the data trace.

BW TEST on OFF. turns bandpass filter bandwidth testing on or off. When bandwidth testing is on, the analyzer locates the maximum point of the data trace and uses it as the reference from which to measure the filter's bandwidth. Then, the analyzer determines the two cutoff frequencies of the bandpass filter. The cutoff frequencies are the two points on the data trace at a user-specified amplitude below the reference point. The cutoff frequencies are also referred to as the *N dB Points* where "*N*" is defined as the number of decibels below the peak of the bandpass that the filter is specified. (The amplitude is specified using the **N DB POINTS** softkey.) The bandwidth is the frequency difference between the two cutoff frequencies. The bandwidth is compared to the user-specified minimum and maximum bandwidth limits (entered using the **MINIMUM BANDWIDTH** and **MAXIMUM BANDWIDTH** softkeys.) If the test passed, a message is displayed in green text in the upper left portion of the LCD. An example of this message is: BW1: Pass, where the "1" indicates the channel where the bandwidth test is performed. If the bandwidth test does not pass, a fail message indicating whether the bandpass was too wide or too narrow is displayed in red text. An example of this message is BW1: Wide.

C0. is used to enter the C0 term in the definition of an OPEN standard in a calibration kit, which is the constant term of the cubic polynomial and is scaled by 10^{-15}.

C1. is used to enter the C1 term, expressed in F/Hz (Farads/Hz) and scaled by 10^{-27}.

C2. is used to enter the C2 term, expressed in F/Hz^2 and scaled by 10^{-36}.

C3. is used to enter the C3 term, expressed in F/Hz^3 and scaled by 10^{-45}.

Cal. key leads to a series of menus to perform measurement calibrations for vector error correction (accuracy enhancement), and for specifying the calibration standards used. The **CAL** key also leads to softkeys which activate interpolated error correction and power meter calibration.

CAL FACTOR. accepts a power sensor calibration factor % for the segment.

CAL FACTOR SENSOR A. brings up the segment modify menu and segment edit (calibration factor menu) which allows you to enter a power sensor's calibration factors. The calibration factor data entered in this menu will be stored for power sensor A.

CAL INTERP ON off. sets the preset state of interpolated error-correction on or off.

CAL FACTOR SENSOR B. brings up the segment modify menu and segment edit (calibration factor menu) which allows you to enter a power sensor's calibration factors. The calibration factor data entered in this menu will be stored for power sensor B.

CAL KIT. indicates the currently selected cal kit and leads to the select cal kit menu, which is used to select one of the default calibration kits available for different connector types. This, in turn, leads to additional menus used to define calibration standards other than those in the default kits "Electrical Calibration Kit Modifications" on page 5-43. When a calibration kit has been specified, its connector type is displayed in brackets in the softkey label. The cal kits available are listed below.

2.4mm 85056
2.92 85056K
2.92mm other kits
3.5mm C 85033C
3.5mm E 85033D/E
3.5mm D 85052D
7-16 85038
7mm 85050
N 50Ω 85032 F
N 50Ω 85054
N 75Ω 85036
TRL 3.5 mm 85052C

CAL ZO: LINE ZO. this default selection establishes the TRL/LRM LINE/MATCH standard as the characteristic impedance.

CAL ZO: SYSTEM ZO. allows you to modify the characteristic impedance of the system for TRL/LRM calibration.

CALIBRATE MENU. leads to the calibration menu, which provides several accuracy enhancement procedures ranging from a simple frequency response calibration to a full two-port calibration. At the completion of a calibration procedure, this menu is returned to the screen, correction is automatically turned on, and the notation `Cor` or `C2` is displayed at the left of the screen.

Center. is used, along with the **Span** key, to define the frequency range of the stimulus. When the **Center** key is pressed, its function becomes the active function. The value is displayed in the active entry area, and can be changed with the knob, step keys, or numeric keypad.

CENTER. sets the center frequency of a subsweep in a list frequency sweep.

CH1 DATA [ ]. brings up the printer color selection menu. The channel 1 data trace default color is magenta for color prints.

CH1 DATA LIMIT LN. selects channel 1 data trace and limit line for display color modification.

CH1 MEM. selects channel 1 memory trace for display color modification.

CH1 MEM [ ]. brings up the printer color selection menu. The channel 1 memory trace default color is green for color prints.

CH2 DATA [ ]. brings up the printer color selection menu. The channel 2 data trace default color is blue for color prints.

CH2 DATA LIMIT LN. selects channel 2 data trace and limit line for display color modification.

CH2 MEM. selects channel 2 memory trace for display color modification.

CH2 MEM [ ]. brings up the printer color selection menu. The channel 2 memory trace default color is red for color prints.

CH3 DATA [ ]. brings up the printer color selection menu. The channel 3 data trace default color is magenta for color prints.

CH3 DATA LIMIT LN. selects channel 3 data trace and limit line for display color modification.

CH3 MEM. selects channel 3 memory trace for display color.

CH3 MEM [ ]. brings up the printer color selection menu. The channel 2 data trace default color is green for color prints.

CH4 DATA [ ]. brings up the printer color selection menu. The channel 4 data trace default color is blue for color prints.

CH4 DATA LIMIT LN. selects channel 4 data trace and limit line for display color modification.

CH4 MEM. selects channel 4 memory trace for display color modification.

CH4 MEM [ ]. brings up the printer color selection menu. The channel 2 memory trace default color is red for color prints.

Chan 1 . allows you to select channel 1 as the `active channel.` The active channel is indicated by an amber LED adjacent to the corresponding channel key. All of the channel-specific functions you select, such as format or scale, apply to the active channel. By default, **Chan 1** measures S11 in log mag format.

Chan 2 . allows you to select channel 2 as the `active channel.` The active channel is indicated by an amber LED adjacent to the corresponding channel key. All of the channel-specific functions you select, such as format or scale, apply to the active channel. By default, **Chan 2** measures S21 in log mag format.

Chan 3 . allows you to select channel 3 as the `active channel.` The active channel is indicated by an amber LED adjacent to the corresponding channel key. All of the channel-specific functions you select, such as format or scale, apply to the active channel. **Chan 3** is the auxiliary channel of **Chan 1**.

Chan 4 . allows you to select channel 4 as the `active channel.` The active channel is indicated by an amber LED adjacent to the corresponding channel key. All of the channel-specific functions you select, such as format or scale, apply to the active channel. **Chan 4** is the auxiliary channel of **Chan 2**.

CHAN POWER [COUPLED]. is used to apply the same power levels to Chan 1/3 & 2/4.

CHAN POWER [UNCOUPLED]. is used to apply different power levels to Chan 1/3 & 2/4.

CHANNEL POSITION. configures multiple-channel displays so that the auxiliary channels are adjacent to or beneath the primary channels.

CHOP A and B. measures A and B inputs simultaneously for faster measurements.

CLEAR BIT. when the parallel port is configured for GPIO, 8 output bits can be controlled with this key. When this key is pressed, “TTL OUT BIT NUMBER” becomes the active function. This active function must be entered through the keypad number keys, followed by the **x1** key. The bit is cleared when the **x1** key is pressed. Entering numbers larger than 7 will result in bit 7 being cleared, and entering numbers lower than 0 will result in bit 0 being cleared.

CLEAR LIST. deletes all segments or bands in the list.

CLEAR SEQUENCE. clears a sequence from memory. The titles of cleared sequences will remain in load, store, and purge menus. This is done as a convenience for those who often reuse the same titles.

COAX. defines the standard (and the offset) as coaxial. This causes the analyzer to assume linear phase response in any offsets.

COAXIAL DELAY. applies a linear phase compensation to the trace for use with electrical delay. That is, the effect is the same as if a corresponding length of perfect vacuum dielectric coaxial transmission line was added to the reference signal path.

COEFFIC'T MODEL MENU. leads to menus used to enter coefficients for a polynomial equation model. The coefficient model menus make it possible to enter coeffiecients for a polynomial equation of the fourth order, describing response versus frequency.

COLOR. adjusts the degree of whiteness of the color being modified. Refer to the user’s guide for an explanation of using this softkey for color modification of display attributes.

CONFIGURE EXT DISK. provides access to the configure ext disk menu. This menu contains softkeys used to the disk address, unit number, and volume number.

CONFIGURE MENU. provides access to the configure menu. This menu contains softkeys to control raw offsets, spur avoidance, the test set transfer switch, and user preset settings.

CONTINUE SEQUENCE. resumes a paused sequence.

CONTINUOUS. located under the **Menu** key, is the standard sweep mode of the analyzer, in which the sweep is triggered automatically and continuously and the trace is updated with each sweep.

CONVERSION [ ]. brings up the conversion menu which converts the measured data to impedance (Z) or admittance (Y). When a conversion parameter has been defined, it is shown in brackets under the softkey label. If no conversion has been defined, the softkey label reads **CONVERSION [OFF]**.

Copy. provides access to the menus used for controlling external plotters and printers and defining the plot parameters.

CORRECTION on OFF. turns error correction on or off. The analyzer uses the most recent calibration data for the displayed parameter. If the stimulus state has been changed since calibration, the original state is recalled, and the message "SOURCE PARAMETERS CHANGED" is displayed.

COUNTER: ANALOG BUS. switches the counter to count the analog bus.

COUNTER: DIV FRAC N. switches the counter to count the A14 fractional-N VCO frequency after it has been divided down to 100 kHz for phase-locking the VCO.

COUNTER: FRAC N. switches the counter to count the A14 fractional-N VCO frequency at the node shown on the overall block diagram.

COUNTER: OFF. switches the internal counter off and removes the counter display from the LCD.

COUPLED CH ON off. toggles the channel coupling of stimulus values. With COUPLED CH ON (the preset condition), both channels have the same stimulus values of FREQUENCY, NUMBER of POINTS, SOURCE PWR, NUMBER of GROUPS, SWEEP TIME, IF BW, TRIGGER TYPE, and SWEEP TYPE (the inactive channel takes on the stimulus values of the active channel).

COUPLED SW ON/OFF. couples the RF switch settings to the measurement setup. If the switch is set to OFF, you can set the RF switches manually. The switch will remain in that state until you change it. If the switch is set to ON, the RF switches will revert back to the setup-required state at the end of the sweep.

CW FREQ. is used to set the frequency for power sweep and CW time sweep modes. If the instrument is not in either of these two modes, it is automatically switched into CW time mode.

CW TIME. turns on a sweep mode similar to an oscilloscope. The analyzer is set to a single frequency, and the data is displayed versus time. The frequency of the CW time sweep is set with **CW FREQ** in the stimulus menu.

D2/D1 to D2 on OFF. this math function ratios channels 1 and 2, and puts the results in the channel 2 data array. Both channels must be on and have the same number of points.

DAC NUM HIGH BAND. sets the source tune DAC for frequencies above 20.05 GHz.

DAC NUM LOW BAND. sets the source tune DAC for frequencies below 2.55 GHz.

DAC NUM MID BAND. sets the source tune DAC for frequencies above 2.55 GHz and below 20.05 GHz.

DATA ARRAY on OFF. specifies whether or not to store the error-corrected data on disk with the instrument state.

DATA → MEMORY. stores the current active measurement data in the memory of the active channel. It then becomes the memory trace, for use in subsequent math manipulations or display. If a parameter has just been changed and the * status notation is displayed at the left of the display, the data is not stored in memory until a clean sweep has been executed. The smoothing status of the trace are stored with the measurement data.

DATA ONLY on OFF. stores only the measurement data of the device under test to a disk file. The instrument state and calibration are not stored. This is faster than storing with the instrument state, and uses less disk space. It is intended for use in archiving data that will later be used with an external controller, and data cannot be read back by the analyzer.

DECISION MAKING. presents the sequencing decision making menu under the **Seq** menu.

DECR LOOP COUNTER. decrements the value of the loop counter by 1.

DEFAULT COLORS. returns all the display color settings back to the factory-set default values that are stored in non-volatile memory.

DEFAULT PLOT SETUP. resets the plotting parameters to their default values.

DEFAULT PRNT SETUP. resets the printing parameters to their default values.

DEFINE DISK-SAVE. leads to the define save menu. Use this menu to specify the data to be stored on disk in addition to the instrument state.

DEFINE PLOT. leads to a sequence of three menus. The first defines which elements are to be plotted and the auto feed state. The second defines which pen number is to be used with each of the elements (these are channel dependent.) The third defines the line types (these are channel dependent), plot scale, and plot speed.

DEFINE PRINT. leads to the define print menu. This menu defines the printer mode (monochrome or color) and the auto-feed state.

DEFINE STANDARD. makes the standard number the active function, and brings up the define standard menus. The standard number (1 to 8) is an arbitrary reference number used to reference standards while specifying a class.

DELAY. selects the group delay format, with marker values given in seconds.

DELAY/THRU. defines the standard type as a transmission line of specified length, for calibrating transmission measurements.

DELETE. deletes the segment or the frequency band indicated by the > pointer.

DELETE ALL FILES. deletes all files.

DELETE FILE. deletes a selected file.

DELTA LIMITS. sets the limits an equal amount above and below a specified middle value, instead of setting upper and lower limits separately. This is used in conjunction with **MIDDLE VALUE** or **MARKER → MIDDLE**, to set limits for testing a device that is specified at a particular value plus or minus an equal tolerance. For example, a device may be specified at 0 dB ±3 dB. Enter the delta limits as 3 dB and the middle value as 0 dB.

DENOMIN: B1. the first order coefficient in the denominator of the response versus frequency polynomial equation.

DENOMIN: B2. the second order coefficient in the denominator of the response versus frequency polynomial equation.

DENOMIN: B3. the third order coefficient in the denominator of the response versus frequency polynomial equation.

DENOMIN: B4. the fourth order coefficient in the denominator of the response versus frequency polynomial equation.

DIRECTORY SIZE. lets you specify the number of directory files to be initialized on a disk. This is particularly useful with a hard disk, where you may want a directory larger than the default 256 files, or with a floppy disk you may want to reduce the directory to allow extra space for data files. The number of directory files must be a multiple of 8. The minimum number is 8, and there is no practical maximum limit. Set the directory size before initializing a disk.

DISK UNIT NUMBER. specifies the number of the disk unit in the disk drive that is to be accessed in an external disk store or load routine. This is used in conjunction with the GPIB address of the disk drive, and the volume number, to gain access to a specific area on a disk. The access hierarchy is GPIB address, disk unit number, disk volume number.

DISP MKRS ON off. displays response and stimulus values for all markers that are turned on. Available only if no marker functions are on, for example MKR STATS.

Display. provides access to a series of menus for instrument and active channel display functions. The first menu defines the displayed active channel trace in terms of the mathematical relationship between data and trace memory. Other functions include auxiliary channel enabling, dual channel display (overlaid or split), display intensity, color selection, active channel display title, and frequency blanking.

DISPLAY: DATA. displays the current measurement data for the active channel.

DISPLAY: DATA and MEMORY. displays both the current data and memory traces.

DISPLAY: MEMORY. displays the trace memory for the active channel. This is the only memory display mode where the smoothing of the memory trace can be changed. If no data has been stored in the active memory, a warning message is displayed.

DISPLAY TESTS. leads to a series of service tests for the display.

DO BOTH FWD + REV. activates both forward and reverse measurements of selected calibration standards.

DO BOTH FWD THRUS. activates both forward measurements (reflection and transmission) of the thru standard from the selective enhanced response calibration menus.

DO BOTH REV THRUS. activates both reverse measurements of the thru standard S22/S12 from the S11/S21 selective enhanced response calibration menus.

DO SEQUENCE. has two functions: 1) It shows the current sequences in memory. To run a sequence, press the softkey next to the desired sequence title. 2) When entered into a sequence, this command performs a one-way jump to the sequence residing in the specified sequence position (SEQUENCE 1 through 6). **DO SEQUENCE** jumps to a softkey position, not to a specific sequence title. Whatever sequence is in the selected softkey position will run when the **DO SEQUENCE** command is executed. This command prompts the operator to select a destination sequence position.

DONE 1-PORT CAL. finishes one-port calibration (after all standards are measured) and turns error correction on.

DONE 2-PORT CAL. finishes two-port calibration (after all standards are measured) and turns error correction on.

DONE FWD ENH. RESP. finishes the transmission portion of the enhanced response calibration.

DONE LOADS. finishes all the load standards when the cal kit defines more than one load standard.

DONE OPENS. finishes all the open standards when the cal kit defines more than one open standard.

DONE SHORTS. finishes all the short standards when the cal kit defines more than one short standard.

DONE RESP ISOL'N CAL. finishes response and isolation calibration (after all standards are measured) and turns error correction on.

DONE REV ENH. RESP. finishes the transmission portion of the enhanced response calibration.

DONE SEQ MODIFY. terminates the sequencing edit mode.

DONE TRL/LRM. finishes TRL/LRM two-port calibration (after all standards are measured) and turns error correction on.

DRIVEPORT LW / RF. allows you to manually set the RF drive port. If COUPLED SW is set to ON, the driveport will automatically change back to the setup-defined setting at the end of the sweep. It is not recommended to change this setting.

DUAL CH on OFF. toggles between the display of both measurement channels or the active channel only. This is used in conjunction with **SPLIT DISP 1X 2X 4X** in the display **DUAL|QUAD SETUP** menu to display multiple channels. With **SPLIT DISP 1X** the two traces are overlaid on a single graticule.

DUAL|QUAD SETUP. activates a sub-menu of **Display**, which allows you to enable the auxiliary channels and configure multiple-channel displays.

DUPLICATE SEQUENCE. duplicates a sequence currently in memory into a different softkey position. Duplicating a sequence is straightforward. Follow the prompts on the analyzer screen. This command does not affect the original sequence.

EACH SWEEP. Power meter calibration occurs on each sweep. Each measurement point is measured by the power meter, which provides the analyzer with the actual power reading. The analyzer corrects the power level at that point. The number of measurement/correction iterations performed on each point is determined by the **NUMBER OF READINGS** softkey. This measurement mode sweeps slowly, especially when the measured power is low. Low power levels require more time for the power meter to settle. The power meter correction table in memory is updated after each sweep. This table can be read or changed via GPIB.

EDIT LIMIT LINE. displays a table of limit segments on the LCD, superimposed on the trace. The edit limits menu is presented so that limits can be defined or changed. It is not necessary for limit lines or limit testing to be on while limits are defined.

EDIT LIST. presents the edit list menu. This is used in conjunction with the edit subsweep menu to define or modify the frequency sweep list. The list frequency sweep mode is selected with the **LIST FREQ** softkey described below.

EDIT RIPL LIMIT. selects the menu used to edit the ripple limits. The edit ripple limits menu allows you to add, change, or delete ripple limits for the ripple test.

ELECTRICAL DELAY. adjusts the electrical delay to balance the phase of the DUT. It simulates a variable length loss-less transmission line, which can be added to or removed from a receiver input to compensate for interconnecting cables, etc. This function is similar to the mechanical or analog “line stretchers” of other analyzers. Delay is annotated in units of time with secondary labeling in distance for the current velocity factor.

ELECTRICAL PARAMETERS. presents a menu that allows you to select an electrical measurement: S11, S21, S12, S22, or direct sampler inputs.

EMIT BEEP. causes the instrument to beep once.

END OF LABEL. terminates the HPGL "LB" command.

END SWEEP HIGH PULSE. sets the TTL output on TEST SEQ BNC or the test set interconnect to normally high with a 10 microseconds pulse high at the end of each sweep.

END SWEEP LOW PULSE. sets the TTL output on TEST SEQ BNC or the test set interconnect to normally low with a 10 µs pulse low at the end of each sweep.

ENHANCED RESPONSE. provides access to the series of menus used to perform an enhanced response calibration.

ENH. REFL. on OFF. selects the enhanced reflection calibration. This calibration improves the response of an enhanced response calibration. Use enhanced reflection only on a bilateral device. A bilateral device has similar forward and reverse transmission characteristics. Examples of bilateral devices are passive devices (filters, attenuators, and switches). Most active devices (amplifiers) and some passive devices (isolators and circulators) are not bilateral. If this calibration is used for a non-bilateral device, errors may occur in the resulting measurement.

ENTRY Off. turns the active entry off. This also removes error and warning messages.

EO CAL Parameter. shows the internal path used during E/O mode calibration.

ERASE TITLE. deletes the entire title.

EXT TRIG ON POINT. is similar to the trigger on sweep, but triggers each data point in a sweep.

EXT TRIG ON SWEEP. is used when the sweep is triggered on an externally generated signal connected to the rear panel EXT TRIGGER input. The sweep is started with a high to low transition of a TTL signal. If this key is pressed when no external trigger signal is connected, the notation “Ext” is displayed at the left side of the display to indicate that the analyzer is waiting for a trigger. When a trigger signal is connected, the “Ext” notation is replaced by the sweep speed indicator either in the status notation area or on the trace. External trigger mode is allowed in every sweep mode.

EXTENSION INPUT A. Use this feature to add electrical delay (in seconds) to extend the reference plane at input A to the end of the cable. This is used for any input measurements including S-parameters.

EXTENSION INPUT B. adds electrical delay to the input B reference plane for any B input measurements including S-parameters.

EXTENSION PORT 1. extends the reference plane for measurements of S_{11}, S_{21}, and S_{12}.

EXTENSION PORT 2. extends the reference plane for measurements of S_{22}, S_{12}, and S_{21}.

EXTENSIONS on OFF. toggles the reference plane extension mode. When this function is on, all extensions defined above are enabled; when off, none of the extensions are enabled.

EXTENSION OPTICAL OUTPUT. extends the reference plane for measurements of O/O and E/O devices.

EXTERNAL DISK. selects an (optional) external disk drive for SAVE/RECALL.

EXTERNAL TESTS. leads to a series of service tests.

FILETITLE FILE0. appears during sequence modification, when external disk is selected. FILE0 is the default name. A new name can be entered when you save the state to disk.

FILETYPE: GRAPHIC. saves the display to the disk drive as a graphic file when **SAVE FILE is** pressed. The format of the graphic file is determined by the **GRAPH FMT [ ]** selection.

FILETYPE: TEXT. saves the display to the disk drive as a text file when**SAVE FILE** is pressed. The form of the text file is determined by the **TEXT FMT [ ]** selection.

FILE NAME FILE0. supplies a name for the saved state and or data file. Brings up the TITLE FILE MENU.

FILE UTILITIES. provides access to the file utilities menu.

FIXED. defines the load in a calibration kit as a fixed (not sliding) load.

FIXED MKR AUX VALUE. is used only with a polar or Smith format. It changes the auxiliary response value of the fixed marker. This is the second part of a complex data pair, and applies to a magnitude/phase marker, a real/imaginary marker, an R+jX marker, or a G+jB marker. Fixed marker auxiliary response values are always uncoupled in the two channels. To read absolute active marker auxiliary values following a **MKR ZERO** operation, the auxiliary value can be reset to zero.

FIXED MKR POSITION. leads to the fixed marker menu, where the stimulus and response values for a fixed reference marker can be set arbitrarily.

FIXED MKR STIMULUS. changes the stimulus value of the fixed marker. Fixed marker stimulus values can be different for the two channels if the channel markers are uncoupled using the marker mode menu. To read absolute active marker stimulus values following a **MKR ZERO** operation, the stimulus value can be reset to zero.

FIXED MKR VALUE. changes the response value of the fixed marker. In a Cartesian format this is the y-axis value. In a polar or Smith chart format with a magnitude/phase marker, a real/imaginary marker, an R+jX marker, or a G+jB marker, this applies to the first part of the complex data pair. Fixed marker response values are always uncoupled in the two channels. To read absolute active marker response values following a **MKR ZERO** operation, the response value can be reset to zero.

FLAT LINE. defines a flat limit line segment whose value is constant with frequency or other stimulus value. This line is continuous to the next stimulus value, but is not joined to a segment with a different limit value. If a flat line segment is the final segment it terminates at the stop stimulus. A flat line segment is indicated as FL on the table of limits.

FORM FEED. puts a form feed command into the display title.

Format. presents a menu used to select the display format for the data. Various rectangular and polar formats are available for display of magnitude, phase, impedance, group delay, real data, and SWR.

FORMAT ARY on OFF. specifies whether or not to store the formatted data on disk with the instrument state.

FORMAT DISK. brings up a menu for formatting a LIF or DOS disk.

FORMAT: DOS. causes subsequent disk initialization to use the DOS disk format.

FORMAT: LIF. causes subsequent disk initialization to use the LIF disk format. **FORMAT: DOS** is the default setting.

FORMAT EXT DISK. initializes media in external drive, and formats the disk using the selected (DOS or LIF) format.

FORMAT INT DISK. initializes media in internal drive, and formats the disk using the selected (DOS or LIF) format.

FORMAT INT MEMORY. clears all internal save registers and associated cal data and memory traces.

FORWARD: OPENS. provides access to the menu for selecting an open calibration type when the cal kit defines more than one open standard.

FRESNEL. in the Optical Kit, Modify Standards menu, this key is used to modify the Fresnel reflection model coefficient.

in the optical reflection and transmission Response Calibration menus, this key is used to measure a Fresnel reference standard (14.5 dB return loss, or 3.5% reflection).

FREQUENCY. specifies the frequency of a calibration factor or loss value in the power meter cal loss/sensor lists.

FREQUENCY BAND. selects an existing frequency band to be reviewed, edited, or deleted. The maximum number of frequency bands is 12 (numbered 1 to 12).

FREQUENCY BLANK. blanks the displayed frequency notation for security purposes. Frequency labels cannot be restored except by instrument preset or turning the power off and then on.

FULL 2-PORT. provides access to the series of menus used to perform a complete calibration for measurement of all four S-parameters of a two-port device. This is the most accurate calibration for measurements of two-port devices.

FULL PAGE. draws a full-size plot according to the scale defined with **SCALE PLOT** in the define plot menu.

FWD ISOL'N. measures the forward isolation of the calibration standard.

FWD MATCH (Label Class). lets you enter a label for the forward match class. The label appears during a calibration that uses this class.

FWD MATCH (Specify Class). specifies which standards are in the forward match class in the calibration kit.

FWD MATCH THRU. measures the forward match using a thru standard.

FWD TRANS (Label Class) lets you enter a label for the forward transmission class. The label appears during a calibration that uses this class.

FWD TRANS (Specify Class) specifies which standards are in the forward transmission class in the calibration kit.

FWD TRANS THRU. measures the forward transmission frequency response in a two-port calibration.

G+jB MKR. displays the complex admittance values of the active marker in rectangular form. The active marker values are displayed in terms of conductance (in Siemens), susceptance, and equivalent capacitance or inductance. Siemens are the international units of admittance, and are equivalent to mhos (the inverse of Ωs). The Smith chart graticule is changed to admittance form.

G/n. giga/nano (10^9 / 10^{-9}). Used to terminate numeric entries.

GET SEQ TITLES. copies the sequence titles currently in memory into the six softkey positions.

GOSUB SEQUENCE. calls sub-routines in sequencing.

GPIB DIAG on off. toggles the GPIB diagnostic feature (debug mode). This mode should only be used the first time a program is written: if a program has already been debugged, it is unnecessary. When diagnostics are on, the analyzer scrolls a history of incoming GPIB commands across the display in the title line. Nonprintable characters are represented as pi. If a syntax error is received, the commands halt and a pointer wedge indicates the misunderstood character. For information on clearing a syntax error, refer to the programmer's guide.

GRAPH FMT [ ]. sets the format of the graphic file when **FILETYPE: GRAPHIC** is selected. The only graphic selection currently available is the JPEG format.

GRAPHICS on OFF. specifies whether or not to store display graphics on disk with the instrument state.

GRATICULE [ ]. brings up the graticule print color definition menu. The graticule default print color is cyan.

GRATICULE. selects the display graticule for color modification.

HELP ADAPT REMOVAL. provides an on-line quick reference guide to using the adapter removal technique.

HOLD. freezes the data trace on the display, and the analyzer stops sweeping and taking data. The notation “Hld” is displayed at the left of the graticule. If the * indicator is on at the left side of the display, trigger a new sweep with **SINGLE**.

IF BW [ ]. is used to select the bandwidth value for IF bandwidth reduction. Allowed values (in Hz) are 6000, 3700, 3000, 1000, 300, 100, 30, and 10. Any other value will default to the closest allowed value. A narrow bandwidth slows the sweep speed but provides better signal-to-noise ratio. The selected bandwidth value is shown in brackets in the softkey label.

IF LIMIT TEST FAIL. jumps to one of the six sequence positions (SEQUENCE 1 through 6) if the limit test fails. This command executes any sequence residing in the selected position. Sequences may jump to themselves as well as to any of the other sequences in memory. When this softkey is pressed, the analyzer presents a softkey menu showing the six sequence positions and the titles of the sequences located in them. Choose the destination sequence to be called if the limit test fails.

IF LIMIT TEST PASS. jumps to one of the six sequence positions (SEQUENCE 1 through 6) if the limit test passes. This command executes any sequence residing in the selected position. Sequences may jump to themselves as well as to any of the other sequences in memory. When this softkey is pressed, the analyzer presents a softkey menu showing the six sequence positions, and the titles of the sequences located in them. Choose the sequence to be called if the limit test passes (destination sequence).

IF LOOP COUNTER = 0. prompts the user to select a destination sequence position (SEQUENCE 1 through 6). When the value of the loop counter reaches zero, the sequence in the specified position will run.

IF LOOP COUNTER < > 0. prompts the user to select a destination sequence position (SEQUENCE 1 through 6). When the value of the loop counter is no longer zero, the sequence in the specified position will run.

IMAGINARY. displays only the imaginary (reactive) portion of the measured data on a Cartesian format. This format is similar to the real format except that reactance data is displayed on the trace instead of impedance data.

INCR LOOP COUNTER. increments the value of the loop counter by 1.

INPUT PORTS. accesses a menu that allows you to measure the R, A, and B channels and their ratios.

INSTRUMENT MODE. presents the instrument mode menu. This provides access to the primary modes of operation (analyzer modes).

INTENSITY. sets the LCD intensity as a percent of the brightest setting. The factory-set default value is stored in non-volatile memory.

INTERNAL TESTS. leads to a series of service tests.

INTERNAL DISK. selects the analyzer internal disk for the storage device.

INTERNAL MEMORY. selects internal non-volatile memory as the storage medium for subsequent save and recall activity.

INTERPOL on OFF. turns interpolated error correction on or off. The interpolated error correction feature allows the operator to calibrate the system, then select a subset of the frequency range or a different number of points. Interpolated error correction functions in linear frequency, power sweep and CW time modes. When using the analyzer in linear sweep, it is recommended that the original calibration be performed with at least 67 points per 1 GHz of frequency span.

ISOLATION. leads to the isolation menu.

ISOLATION DONE. returns to the two-port cal menu.

ISOL'N STD. measures the isolation of the device connected to the test port.

k/m. kilo/milli (10^3 / 10^{-3})

KIT DONE (MODIFIED). terminates the cal kit modification process, after all standards are defined and all classes are specified. Be sure to save the kit with the **SAVE USER KIT** softkey, if it is to be used later.

LABEL CLASS. leads to the label class menu, to give the class a meaningful label for future reference during calibration.

LABEL CLASS DONE. finishes the label class function and returns to the modify cal kit menu.

LABEL KIT. leads to a menu for constructing a label for the user-modified cal kit. If a label is supplied, it will appear as one of the five softkey choices in the select cal kit menu. The approach is similar to defining a display title, except that the kit label is limited to ten characters.

LABEL STD. The function is similar to defining a display title, except that the label is limited to ten characters.

LASER INT / EXT. switches the analyzer between the internal and external laser. When the external laser is selected, the internal laser is automatically switched off.

LASER ON/OFF. allows you to turn the internal laser ON or OFF through the software. The laser key must be in the ON position, and the safety interlock at the rear of the lightwave test set must be in place for this software setting to control the laser.

LEFT LOWER. draws a quarter-page plot in the lower left quadrant of the page.

LEFT UPPER. draws a quarter-page plot in the upper left quadrant of the page.

LIGHTWAVE PARAMETERS. presents a menu that allows you to select a lightwave measurement: optical reflection, optical transmission, electrical-to-optical transmission, and optical-to-electrical transmission.

LIGHTWAVE TESTS. leads to the internal service test for the lightwave portion of the hardware.

LIMIT LINE. selects the standard limit line choice. This selection leads to a series of menus used to define limits or specifications with which to compare a test device. Refer to “Limit Line Operation” in the “Operating Concepts” chapter of the user’s guide and the limit line testing section of the “Making Measurements” chapter of the user’s guide.

LIMIT LINE OFFSETS. leads to the offset limits menu, which is used to offset the complete limit set in either stimulus or amplitude value.

LIMIT LINE on OFF. turns limit lines on or off. To define limits, use the **EDIT LIMIT LINE** softkey described below. If limits have been defined and limit lines are turned on, the limit lines are displayed on the LCD for visual comparison of the measured data in all Cartesian formats. If limit lines are on, they are plotted with the data on a plot, and saved in memory with an instrument state. In a listing of values from the copy menu with limit lines on, the upper limit and lower limit are listed together with the pass or fail margin, as long as other listed data allows sufficient space.

LIMIT MENU. accesses the menu that allows you to set up the three limit line types: standard limit lines, ripple limit lines, and bandwidth limit lines.

LIMIT TEST on OFF. turns limit testing on or off. When limit testing is on, the data is compared with the defined limits at each measured point. Limit tests occur at the end of each sweep, whenever the data is updated, when formatted data is changed, and when limit testing is first turned on. Limit testing is available for both magnitude and phase values in Cartesian formats. In polar and Smith chart formats, the value tested depends on the marker mode and is the magnitude or the first value in a complex pair. The message "NO LIMIT LINES DISPLAYED" is displayed in polar and Smith chart formats if limit lines are turned on. Five indications of pass or fail status are provided when limit testing is on. A PASS or FAIL message is displayed at the right of the LCD. The trace vector leading to any measured point that is out of limits is set to red at the end of every limit test, both on a displayed plot and a hard copy plot. The limit fail beeper sounds if it is turned on. In a listing of values using the copy menu, an asterisk * is shown next to any measured point that is out of limits. A bit is set in the GPIB status byte.

LIMIT TEST RESULT. puts the result of a limit test into the display title.

LIMIT TYPE. leads to the limit type menu, where one of three segment types can be selected: sloping line, flat line, or single point.

LIN FREQ. activates a linear frequency sweep displayed on a standard graticule with ten equal horizontal divisions. This is the default preset sweep type.

LIN MAG. displays the linear magnitude format. This is a Cartesian format used for unitless measurements such as reflection coefficient magnitude ρ or transmission coefficient magnitude τ, and for linear measurement units. It is used for display of conversion parameters and time domain transform data.

LIN MKR. displays a readout of the linear magnitude and the phase of the active marker. Marker magnitude values are expressed in units and phase is expressed in degrees.

LINE/MATCH. provides access to the Line/Match Menu for TRL/LRM calibration.

LINE TYPE DATA. selects the line type for the data trace plot. The default line type is 7, which is a solid unbroken line.

LINE TYPE MEMORY. selects the line type for the memory trace plot. The default line type is 7.

LIST. provides a tabular listing of all the measured data points and their current values, together with limit information if it is turned on. At the same time, the screen menu is presented, to enable hard copy listings and access new pages of the table. 30 lines of data are listed on each page, and the number of pages is determined by the number of measurement points specified in the stimulus menu.

LIST FREQ [STEPPED] or [SWEPT]. provides two user-definable arbitrary frequency list modes. This list is defined and modified using the edit list menu and the edit subsweep menu. Up to 30 frequency subsweeps (called “segments”) of several different types can be specified, for a maximum total of 1601 points. One list is common to both channels. Once a frequency list has been defined and a measurement calibration performed on the full frequency list, one or all of the frequency segments can be measured and displayed without loss of calibration. For more information on the different list frequency sweep modes, refer to “Sweep Types” on page 5-6“.

LIST IF BW on OFF. enables or disables the ability to set independent IF bandwidths for each segment in a swept list measurement.

LIST POWER on OFF. enables or disables the ability to set independent power levels for each segment in a swept list measurement. When on, sets power range mode to manual to set a range for the power values. (The range can be chosen using the **PWR RANGE** key.) The power values can be entered using the **SEGMENT POWER** key. If ports are uncoupled, the power can be set independently for each port. When off, the **SEGMENT POWER** key will not function and the power column in the swept list table will display asterisks. In this case, the power is set by the normal test port power value.

LIST TYPE [STEPPED]. selects either stepped or swept list mode. For in-depth information on stepped list mode, refer to “Stepped List Frequency Sweep (Hz)” on page 5-7“.

LIST VALUES. provides a tabular listing of all the measured data points and their current values, together with limit information if it is turned on. At the same time, the screen menu is presented, to enable hard copy listings and access new pages of the table. 30 lines of data are listed on each page, and the number of pages is determined by the number of measurement points specified in the stimulus menu.

LN/MATCH 1. measures the TRL/LRM line or match standard for PORT 1.

LN/MATCH 2. measures the TRL/LRM line or match standard for PORT 2.

LOAD. defines the standard type as a load (termination). Loads are assigned a terminal impedance equal to the system characteristic impedance Z0, but delay and loss offsets may still be added. If the load impedance is not Z0, use the arbitrary impedance standard definition.

LOAD NO OFFSET. initiates measurement of a calibration standard load without offset.

LOAD OFFSET. initiates measurement of a calibration standard load with offset.

LOAD SEQ FROM DISK. presents the load sequence from disk menu. Select the desired sequence and the analyzer will load it from disk.

Local. This key is used to return the analyzer to local (front panel) operation from remote (computer controlled) operation. This key will also abort a test sequence or hardcopy print/plot. In this local mode, with a controller still connected on GPIB, the analyzer can be operated manually (locally) from the front panel. This is the only front panel key that is not disabled when the analyzer is remotely controlled over GPIB by a computer. The exception to this is when local lockout is in effect: this is a remote command that disables the **Local** key, making it difficult to interfere with the analyzer while it is under computer control.

LOG FREQ. activates a logarithmic frequency sweep mode. The source is stepped in logarithmic increments and the data is displayed on a logarithmic graticule. This is slower than a continuous sweep with the same number of points, and the entered sweep time may therefore be changed automatically. For frequency spans of less than two octaves, the sweep type automatically reverts to linear sweep.

LOG MAG. displays the log magnitude format. This is the standard Cartesian format used to display magnitude-only measurements of insertion loss, return loss, or absolute power in dB versus frequency.

LOG MKR. displays the logarithmic magnitude value and the phase of the active marker in Polar or Smith chart format. Magnitude values are expressed in dB and phase in degrees. This is useful as a fast method of obtaining a reading of the log magnitude value without changing to log magnitude format.

LOOP COUNTER. displays the current value of the loop counter and allows you to change the value of the loop counter. Enter any number from 0 to 32767 and terminate with the **x1** key. The default value of the counter is zero. This command should be placed in a sequence that is separate from the measurement sequence. For this reason: the measurement sequence containing a loop decision command must call itself in order to function. The **LOOP COUNTER** command must be in a separate sequence or the counter value would always be reset to the initial value.

LOOP COUNTER (Sequence Filenaming). inserts the string “[LOOP]” into the file name.

LOSS. accepts a power loss value for a segment in the power meter cal power loss list. This value, for example, could be the difference (in dB) between the coupled arm and through arm of a directional coupler.

LOSS/SENSR LISTS. presents the power loss/sensor lists menu. This menu performs two functions: 1) Corrects coupled-arm power loss when a directional coupler is used to sample the RF output. 2) Allows calibration factor data to be entered for one or two power sensors. Each function provides up to 12 separate frequency points, called segments, at which the user may enter a different power loss or calibration factor. The instrument interpolates between the selected points. Two power sensor lists are provided because no single power sensor can cover the frequency range of the analyzer.

LOWER LIMIT. sets the lower limit value for the start of the segment in a limit line list. If an upper limit is specified, a lower limit must also be defined. If no lower limit is required for a particular measurement, force the lower limit value out of range (for example –500 dB).

MANUAL TRG ON POINT. waits for a manual trigger for each point. Subsequent pressing of this softkey triggers each measurement. The annotation “man” will appear at the left side of the display when the instrument is waiting for the trigger to occur. This feature is useful in a test sequence when an external device or instrument requires changes at each point.

Marker. displays an active marker on the screen and provides access to a series of menus to control from one to five display markers for each channel. Markers provide numerical readout of measured values at any point of the trace. The menus accessed from the **Marker** key provide several basic marker operations. These include special marker modes for different display formats, and a marker delta mode that displays marker values relative to a specified value or another marker.

MARKER → AMP. OFS. uses the active marker to set the amplitude offset for the limit lines. Move the marker to the desired middle value of the limits and press this softkey. The limits are then moved so that they are centered an equal amount above and below the marker at that stimulus value.

MARKER → CENTER. changes the stimulus center value to the stimulus value of the active marker, and centers the new span about that value.

MARKER → CW. sets the CW frequency of the analyzer to the frequency of the active marker. This feature is useful in automated compression measurements. Test sequences allow the instrument to automatically find a maximum or minimum point on a response trace. The **MARKER → CW** command sets the instrument to the CW frequency of the active marker. When power sweep in engaged, the CW frequency will already be selected.

MARKER → DELAY. adjusts the electrical delay to balance the phase of the DUT. This is performed automatically, regardless of the format and the measurement being made. Enough line length is added to or subtracted from the receiver input to compensate for the phase slope at the active marker position. This effectively flattens the phase trace around the active marker, and can be used to measure electrical length or deviation from linear phase. Additional electrical delay adjustments are required on DUTs without constant group delay over the measured frequency span. Since this feature adds phase to a variation in phase versus frequency, it is applicable only for ratioed inputs.

MARKER → MIDDLE. sets the midpoint for **DELTA LIMITS** using the active marker to set the middle amplitude value of a limit segment. Move the marker to the desired value or device specification, and press this key to make that value the midpoint of the delta limits. The limits are automatically set an equal amount above and below the marker.

MARKER → REFERENCE. makes the reference value equal to the active marker's response value, without changing the reference position. In a polar or Smith chart format, the full scale value at the outer circle is changed to the active marker response value. This softkey also appears in the scale reference menu.

MARKER → SPAN. changes the start and stop values of the stimulus span to the values of the active marker and the delta reference marker. If there is no reference marker, the message
"NO MARKER DELTA – SPAN NOT SET" is displayed.

MARKER → START. changes the stimulus start value to the stimulus value of the active marker.

MARKER → STIMULUS. sets the starting stimulus value of a limit line segment using the active marker. Move the marker to the desired starting stimulus value before pressing this key, and the marker stimulus value is entered as the segment start value.

MARKER → STOP. changes the stimulus stop value to the stimulus value of the active marker.

MARKER 1. turns on marker 1 and makes it the active marker. The active marker appears on the display as ∇. The active marker stimulus value is displayed in the active entry area, together with the marker number. If there is a marker turned on, and no other function is active, the stimulus value of the active marker can be controlled with the knob, the step keys, or the numeric keypad. The marker response and stimulus values are displayed in the upper right-hand corner of the screen.

MARKER 2. turns on marker 2 and makes it the active marker. If another marker is present, that marker becomes inactive and is represented on the display as Δ.

MARKER 3. turns on marker 3 and makes it the active marker.

MARKER 4. turns on marker 4 and makes it the active marker.

MARKER 5. turns on marker 5 and makes it the active marker.

MARKER all OFF. turns off all the markers and the delta reference marker, as well as the tracking and bandwidth functions that are accessed with the **MKR FCTN** key.

Marker Fctn. key activates a marker if one is not already active, and provides access to additional marker functions. These can be used to quickly change the measurement parameters, to search the trace for specified information, and to analyze the trace statistically.

MARKER MODE MENU. provides access to the marker mode menu, where several marker modes can be selected including special markers for polar and Smith chart formats.

MARKERS: CONTINUOUS. located under the **Marker** key, interpolates between measured points to allow the markers to be placed at any point on the trace. Displayed marker values are also interpolated. This is the default marker mode.

MARKERS: COUPLED. couples the marker stimulus values for the two display channels. Even if the stimulus is uncoupled and two sets of stimulus values are shown, the markers track the same stimulus values on each channel as long as they are within the displayed stimulus range.

MARKERS: DISCRETE. places markers only on measured trace points determined by the stimulus settings.

MARKERS: UNCOUPLED. allows the marker stimulus values to be controlled independently on each channel.

MATH: DATA/MEM. divides the data by the memory, normalizing the data to the memory, and displays the result. This is useful for ratio comparison of two traces, for instance in measurements of gain or attenuation.

MATH: DATA - MEM. subtracts the memory from the data. The vector subtraction is performed on the complex data. This is appropriate for storing a measured vector error, for example directivity, and later subtracting it from the device measurement.

MATH: DATA * MEM. multiplies memory and data.

MATH: DATA + MEM. adds memory and data.

MATH: MEM / DATA . divides memory by data. This operation normalizes the memory to the data. This is useful for ratio comparison of two traces, for instance in measurements of gain or attenuation.

MATH: MEM - DATA . subtracts memory from data.

MATH: MEM1 / MEM2 . divides memory 1 by memory 2.

MATH: MEM1 - MEM2 . subtracts memory 2 from memory 1.

MATH: MEM1 * MEM2 . multiplies memory 1 and memory 2.

MATH: MEM1 + MEM2 . adds memory 1 and memory 2.

MATH: MEM2 / MEM1 . divides memory 2 by memory 1.

MATH: MEM2 - MEM1 . subtracts memory 1 from memory 2.

MAX. moves the active marker to the maximum point on the trace.

MAXIMUM BANDWIDTH. sets the maximum bandwidth value of the bandwidth test limits.

MAXIMUM FREQUENCY. is used to: 1) define the highest frequency at which a calibration kit standard can be used during measurement calibration. In waveguide, this is normally the upper cutoff frequency of the standard. *or* 2) set the maximum frequency of the selected frequency band when setting up ripple test parameters.

MAXIMUM RIPPLE. sets the maximum ripple allowed of the selected frequency band. The maximum allowable ripple is 100 dB.

Marker Search. allows user to turn tracking on, off and search for the maximum, minimum, bandwidth, and target points on the trace.

Meas. key provides access to a series of lightwave measurements and a softkey menus for selecting the electrical parameters or inputs to be measured.

MEASURE RESTART. aborts the sweep in progress, then restarts the measurement. This can be used to update a measurement following an adjustment of the device under test. When a full two-port calibration is in use, the **MEASURE RESTART** key will initiate another update of both forward and reverse data. This softkey will also override the test set hold mode, which inhibits continuous switching of either the test port transfer switch or step attenuator. This softkey will override the test set hold mode for one measurement. If the analyzer is taking a number of groups, the sweep counter is reset at 1. If averaging is on, **MEASURE RESTART** resets the sweep-to-sweep averaging and is effectively the same as **AVERAGING RESTART**. If the sweep trigger is in **HOLD** mode, **MEASURE RESTART** executes a single sweep.

MEMORY. displays the trace memory for the active channel. This is the only memory display mode where the smoothing of the memory trace can be changed. If no data has been stored in memory for this channel, a warning message is displayed.

MEMORY1. causes memory 1 to be the active memory.

MEMORY2. causes memory 2 to be the active memory.

MEMORY1 → 2. copies the contents of memory 1 into memory 2.

MEMORY2 → 1. copies the contents of memory 2 into memory 1.

MIDDLE VALUE. sets the midpoint for **DELTA LIMITS**. It uses the entry controls to set a specified amplitude value vertically centered between the limits.

MIN. moves the active marker to the minimum point on the trace.

MINIMUM BANDWIDTH. sets the minimum bandwidth value of the bandwidth test limits.

MINIMUM FREQUENCY . is used to: 1) define the lowest frequency at which a calibration kit standard can be used during measurement calibration. In waveguide, this must be the lower cutoff frequency of the standard, so that the analyzer can calculate dispersive effects correctly (see **OFFSET DELAY**). *or* 2) set the minimum frequency of the selected frequency band when setting up ripple test parameters.

MKR SEARCH [ ]. leads to the marker search menu, which is used to search the trace for a particular value or bandwidth.

MKR ZERO. puts a fixed reference marker at the present active marker position, and makes the fixed marker stimulus and response values at that position equal to zero. All subsequent stimulus and response values of the active marker are then read out relative to the fixed marker. The fixed marker is shown on the display as a small triangle Δ (delta), smaller than the inactive marker triangles. The softkey label changes from **MKR ZERO** to **MKR ZERO ΔREF =** Δ and the notation "ΔREF = Δ" is displayed at the top right corner of the graticule. Marker zero is canceled by turning delta mode off in the delta marker menu or turning all the markers off with the **ALL OFF** softkey.

MODIFY [ ]. leads to the modify cal kit menu, where a default cal kit can be user-modified.

MODIFY COLORS. present a menu for color modification of display elements. Refer to the user's guide for information on modifying display elements.

MODIFY: FRESNEL. leads to a menu used to modify the Fresnel reflection model coefficient.

MODIFY: REFLECTOR. leads to a menu used to modify the reflector model coefficient.

MODIFY: THRU. leads to a menu used to modify the optical thru model coefficient.

MORE RANGES. provides access to more power ranges.

N 50Ω 85054. selects the 85054 cal kit.

N 50Ω 85032F. selects the 85032F cal kit.

N 75Ω 85036. selects the 85036B/E cal kit.

N DB POINTS. sets the N dB point which is used to determine the bandwidth test cutoff frequencies. Enter the number of decibels below the peak of the bandpass that the filter is specified.

NETWORK ANALYZER. sets the analyzer to network analyzer mode.

NEW SEQ/MODIFY SEQ. activates the sequence edit mode and presents the new/modify sequence menu with a list of sequences that can be created or modified.

NEWLINE. puts a new line command into the display title.

NEXT PAGE. steps forward through a tabular list of data page-by-page.

NUMBER OF GROUPS. triggers a user-specified number of sweeps, and returns to the hold mode. This function can be used to override the test set hold mode (indicated by the notation "tsH" at the left of the screen). In this mode, the electro-mechanical transfer switch and attenuator are not protected against unwanted continuous switching. This occurs in a full two-port calibration, in a measurement of two different parameters that require power out from both ports, or when the channels are uncoupled and a different power level is set for each channel. If averaging is on, the number of groups should be at least equal to the averaging factor selected to allow measurement of a fully averaged trace. Entering a number of groups resets the averaging counter to 1.

NUMBER of POINTS. is used to select the number of data points per sweep to be measured and displayed. Using fewer points allows a faster sweep time but the displayed trace shows less horizontal detail. Using more points gives greater data density and improved trace resolution, but slows the sweep and requires more memory for error correction or saving instrument states. The possible values that can be entered for number of points are 3, 11, 26, 51, 101, 201, 401,801, and 1601. The number of points can be different for the two channels if the stimulus values are uncoupled. In list frequency sweep, the number of points displayed is the total number of frequency points for the defined list (see "Sweep Types" on page 5-6").

NUMBER OF READINGS. determines the number of measurement/correction iterations performed on each point in a power meter calibration. This feature helps eliminate residual power errors after the initial correction. The amount of residual error is directly proportional to the magnitude of the initial correction. The user should initially set the source power so that it is approximately correct at the device under test. If power uncertainty at the device under test is expected to be greater than a few dB, it is recommended that the number of readings be greater than 1.

NUMERATOR: k. is the multiplication constant in the numerator of the response versus frequency coefficient model.

NUMERATOR: DELAY. is a phase or delay factor of the response versus frequency coefficient model. The delay is a function of frequency.

NUMERATOR: A1. is the first order coefficient in the numerator.

NUMERATOR: A2. is the second order coefficient in the numerator.

NUMERATOR: A3. is the third order coefficient in the numerator.

NUMERATOR: A4. is the fourth order coefficient in the numerator.

OFFSET. selects the calibration standard load as being offset.

OFFSET DELAY. is used to specify the one-way electrical delay from the measurement (reference) plane to the standard, in seconds (s). (In a transmission standard, offset delay is the delay from plane to plane.) Delay can be calculated from the precise physical length of the offset, the permittivity constant of the medium, and the speed of light.

OFFSET LENGTH. is used to enter an offset length to adjust the position of the standards to the desired reference plane.

OFFSET LOADS DONE. completes the selection in the Offset Load Menu.

OFFSET LOSS. is used to specify energy loss, due to skin effect, along a one-way length of coax offset. The value of loss is entered as Ωs/nanosecond (or Giga Ωs/second) at 1 GHz. (Such losses are negligible in waveguide, so enter 0 as the loss offset.)

OFFSET Z0. is used to specify the characteristic impedance of the coax offset. (Note: This is not the impedance of the standard itself.) (For waveguide, the offset impedance should always be assigned a value equal to the system Z0.)

OMIT ISOLATION. is used to omit the isolation portion of the calibration.

ONE SWEEP. This mode does not measure each sweep, but corrects each point with the data currently in the power meter correction table.

OP PARMS (MKRS etc). provides a tabular listing on the analyzer display of the key parameters for both channels. The screen menu is presented to allow hard copy listings and access new pages of the table. Four pages of information are supplied. These pages list operating parameters, marker parameters, and system parameters that relate to control of peripheral devices rather than selection of measurement parameters.

OPEN. defines the standard type as an open, used for calibrating reflection measurements. Opens are assigned a terminal impedance of infinite Ωs, but delay and loss offsets may still be added.

OPEN (F). for cal kits with different models for male and female test port standards, this selects the open model for a female test port. Note that the sex of a calibration standard always refers to the test port.

OPEN (M). for cal kits with different models for male and female test port standards, this selects the open model for a male test port. Note that the sex of a calibration standard always refers to the test port.

OPT. KIT. leads to the optical cal kit menu, which is used to select the default optical cal kit or to modify the cal kit.

P MTR/GPIB TO TITLE. gets data from an GPIB device set to the address at which the analyzer expects to find a power meter. The data is stored in a title string. The analyzer must be in system controller or pass control mode.

PARALL IN BIT NUMBER. while creating a sequence, this softkey will insert a command that selects the single bit (0 to 4) that a sequence will be looking for from the GPIO bus.

PARALL IN IF BIT H. while creating a sequence, this softkey inserts a command to jump to another sequence if the single input selected is in a high state.

PARALL IN IF BIT L. while creating a sequence, this softkey inserts a command to jump to another sequence if the single input selected is in a low state.

PARALLEL. sets the printer or plotter port to parallel.

PARALLEL [COPY/GPIO]. toggles the parallel output port between the copy and GPIO output modes.

PARALLEL OUT ALL. allows you to input a number (0 to 255) in base 10, and outputs it to the bus as binary, when the parallel port is in GPIO mode.

PAUSE. pauses the sequence so the operator can perform a needed task, such as changing the DUT, changing the calibration standard, or other similar task. Press **CONTINUE SEQUENCE** when ready.

PAUSE TO SELECT. when editing a sequence, **PAUSE TO SELECT** appears when you press **DO SEQUENCE**. When placed in a sequence, it presents the menu of up to 6 available sequences (softkeys containing non-empty sequences). If the operator selects one of the sequences, that sequence is executed. Any other key can be used to exit this mode. This function is not executed if used during modify mode and does nothing when operated manually. This softkey is not visible on the display, and the function is not available, unless programmed into analyzer memory.

PEN NUM DATA. selects the number of the pen to plot the data trace. The default pen for channel 1 is pen number 2, and for channel 2 is pen number 3.

PEN NUM GRATICULE. selects the number of the pen to plot the graticule. The default pen for channel 1 is pen number 1, and for channel 2 is pen number 1.

PEN NUM MARKER. selects the number of the pen to plot both the markers and the marker values. The default pen for channel 1 is pen number 7, and for channel 2 is pen number 7.

PEN NUM MEMORY. selects the number of the pen to plot the memory trace. The default pen for channel 1 is pen number 5, and for channel 2 is pen number 6.

PEN NUM TEXT. selects the number of the pen to plot the text. The default pen for channel 1 is pen number 7, and for channel 2 is pen number 7.

PHASE OFFSET. adds or subtracts a phase offset that is constant with frequency (rather than linear). This is independent of **MARKER → DELAY** and **ELECTRICAL DELAY**.

PHASE. displays a Cartesian format of the phase portion of the data, measured in degrees. This format displays the phase shift versus frequency.

PLOT. makes a hard copy plot of one page of the tabular listing on the display, using a compatible plotter connected to the analyzer through GPIB. This method is appropriate when speed of output is not a critical factor.

PLOT DATA ON off. specifies whether the data trace is to be drawn (on) or not drawn (off) on the plot.

PLOT GRAT ON off. specifies whether the graticule and the reference line are to be drawn (on) or not drawn (off) on the plot. Turning **PLOT GRAT ON** and all other elements off is a convenient way to make preplotted grid forms. However, when data is to be plotted on a preplotted form, **PLOT GRAT OFF** should be selected.

PLOT MEM ON off. specifies whether the memory trace is to be drawn (on) or not drawn (off) on the plot. Memory can only be plotted if it is displayed (refer to the “Making Measurements” chapter in the user’s guide).

PLOT MKR ON off. specifies whether the markers and marker values are to be drawn (on) or not drawn (off) on the plot.

PLOT NAME PLOTFILE. supplies a name for the plot file generated by a PLOT to disk. Brings up the TITLE FILE MENU.

PLOT SPEED [ ]. toggles between fast and slow speeds.

PLOT TEXT ON off. selects plotting of all displayed text except the marker values, softkey labels, and display listings such as the frequency list table or limit table. (Softkey labels can be plotted under the control of an external controller. Refer to the programmer’s guide.)

PLOTTER BAUD RATE. sets the serial port data transmission speed for plots.

PLOTTER FORM FEED. sends a page eject command to the plotter.

PLOTTER PORT. configures the port analyzer will use to communicate with the plotter.

PLTR PORT: DISK. directs plots to the selected disk (internal or external).

PLTR PORT GPIB. directs plots to the GPIB port and sets the GPIB address the analyzer will use to communicate with the plotter.

PLTR PORT PARALLEL. configures the analyzer for a plotter that has a parallel (centronics) interface.

PLTR PORT SERIAL. configures the analyzer for a plotter that has a serial (RS-232) interface.

PLTR TYPE [PLOTTER]. selects a pen plotter such as the HP 7440A, HP 7470A, HP 7475A, or HP 7550B as the plotter type.

PLTR TYPE [HPGL PRT]. selects a PCL5 compatible printer, which supports HP-GL/2, such as the LaserJet III or LaserJet 4 for a monochrome plotter type, or the DeskJet 1200C for a color plotter type.

POLAR. displays a polar format. Each point on the polar format corresponds to a particular value of both magnitude and phase. Quantities are read vectorally: the magnitude at any point is determined by its displacement from the center (which has zero value), and the phase by the angle counterclockwise from the positive x-axis. Magnitude is scaled in a linear fashion, with the value of the outer circle usually set to a ratio value of 1. Since there is no frequency axis, frequency information is read from the markers.

POLAR MKR MENU. leads to a menu of special markers for use with a polar format.

PORT EXTENSIONS. goes to the reference plane menu, which is used to extend the apparent location of the measurement reference plane or input.

PORT POWER [COUPLED]. is used to set the same power levels at each port.

PORT POWER [UNCOUPLED]. allows you to set different power levels at each port.

Power. makes power level the active function and sets the RF output power level of the analyzer's internal source. The analyzer will detect an input power overload at any of the three receiver inputs. This is indicated with the message "OVERLOAD ON INPUT (R, A, B)." If power meter cal is on, cal power is the active entry.

POWER RANGES. leads to the power ranges menu which allows the user to select among 12 power ranges from –75 to –5 dBm.

POWER LOSS. brings up the segment modify menu and segment edit (power loss) menu explained in the following pages. This softkey is intended for use when the power output is being sampled by a directional coupler or power splitter. In the case of the directional coupler, enter the power loss caused by the coupled arm. This feature may be used to compensate for attenuation non-linearities in either a directional coupler or a power splitter. Up to 12 segments may be entered, each with a different frequency and power loss value.

POWER MTR. toggles between **436A** or **438A/437**. These power meters are GPIB compatible with the analyzer. The model number in the softkey label must match the power meter to be used.

POWER SWEEP. turns on a power sweep mode that is used to characterize power-sensitive circuits. In this mode, power is swept at a single frequency, from a start power value to a stop power value, selected using the **Start** and **Stop** keys and the entry block. This feature is convenient for such measurements as gain compression or AGC (automatic gain control) slope. To set the frequency of the power sweep, use **CW FREQ** in the stimulus menu. Note that power range switching is not allowed in power sweep mode.

In power sweep, the entered sweep time may be automatically changed if it is less than the minimum required for the current configuration (number of points, IF bandwidth, averaging, etc.).

Preset. presents a menu to select a factory or user defined preset state.

PRESET: FACTORY. is used to select the preset conditions defined by the factory.

PRESET: USER. is used to select a preset condition defined by the user. This is done by saving a state in a register under **Save/Recall** and naming the register UPRESET. When **PRESET: USER** is underlined, the **Preset** key will bring up the state of the UPRESET register.

PRESET SETTINGS. selects a menu to set the preset states of some items, such as calibration interpolation and step sweep mode.

PREVIOUS PAGE. steps backward through a tabular list of data page-by-page.

PREVIOUS RANGES. steps back to the previous range menus.

PRINT ALL COLOR. when displaying list values, prints the entire list in color. When displaying operating parameters, prints all but the last page in color. The data is sent to the printer as ASCII text rather than as raster graphics, which causes the printout to be faster.

PRINT ALL MONOCHROME. when displaying list values or operating parameters, prints the entire list in monochrome. The data is sent to the printer as ASCII text rather than as raster graphics, which causes the printout to be faster.

PRINT: COLOR. sets the print command to default to a color printer. The printer output is always in the analyzer default color values. This command does not work with a black and white printer.

PRINT COLOR. prints the displayed measurement results in color.

PRINT COLORS. is used to select the print colors menu.

PRINT: MONOCHROME. sets the print command to default to a black and white printer.

PRINT MONOCHROME. prints the displayed measurement results in black and white.

PRINT SEQUENCE. prints any sequence currently in memory to a compatible printer.

PRINTER BAUD RATE. sets the serial port data transmission speed for prints.

PRINTER FORM FEED. sends a conditional form feed to the printer.

PRINTER PORT. configures the port the analyzer will use to communicate with the printer.

PRNTR PORT GPIB. directs prints to the GPIB port and sets the GPIB address the analyzer will use to communicate with the printer.

PRNTR PORT PARALLEL. configures the analyzer for a printer that has a parallel (centronics) interface.

PRNTR PORT SERIAL. configures the analyzer for a printer that has a serial (RS-232) interface.

PRNTR TYPE [DESKJET]. sets the printer type to the DeskJet series.

PRNTR TYPE [EPSON-P2]. sets the printer type to Epson compatible printers, which support the Epson ESC/P2 printer control language.

PRNTR TYPE [LASERJET]. sets the printer type to the LaserJet series.

PRNTR TYPE [PAINTJET]. sets the printer type to the PaintJet.

PRNTR TYPE [THINKJET]. sets the printer type to the ThinkJet or QuietJet.

PULSE VALUE. sets the two response points at which the pulse width is calculated. Pulse value is the percentage of pulse height where the width is to be measured.

PULSE WIDTH. calculates the width of a pulse.

PWR DAC on OFF. sets the power level directly from the power DAC.

PWR LOSS on OFF. turns on or off power loss correction. Power loss correction should be used when the power output is measured by a directional coupler. Enter the power loss caused by the coupled arm with the **LOSS/SENSR LISTS** softkey submenus described below.

PWR RANGE AUTO man. toggles the power range mode between auto and manual. Auto mode selects the power range based on the power selected. Manual mode limits power entry to within the ±6 to –12 dB selected range.

PWRMTR CAL [ ]. leads to the power meter calibration menu which provides two types of power meter calibration, continuous (each sweep) and single-sample (one sweep).

PWRMTR CAL [OFF]. turns off power meter calibration, terminate a power meter calibration sweep.

R. measures the absolute power amplitude at input R.

R+jX MKR. converts the active marker values into rectangular form. The complex impedance values of the active marker are displayed in terms of resistance, reactance, and equivalent capacitance or inductance. This is the default Smith chart marker. Each of the range softkeys will have different ranges dependent on the analyzer model and options installed.

RANGE 0 -15 TO +10. selects power range 0 when in manual power range.

RANGE 1 -25 TO 0. selects power range 1 when in manual power range.

RANGE 2 -35 TO -10. selects power range 2 when in manual power range.

RANGE 3 -45 TO -20. selects power range 3 when in manual power range.

RANGE 4 -55 TO -30. selects power range 4 when in manual power range.

RANGE 5 -65 TO -40. selects power range 5 when in manual power range.

RANGE 6 -75 TO -50. selects power range 6 when in manual power range.

RANGE 7 -85 TO -60. selects power range 7 when in manual power range.

RANGE 4 -55 TO -30. selects power range 8 when in manual power range.

RANGE 5 -65 TO -40. selects power range 9 when in manual power range.

RANGE 6 -75 TO -50. selects power range 10 when in manual power range.

RANGE 7 -85 TO -60. selects power range 11 when in manual power range.

RAW ARRAY on OFF. specifies whether or not to store the raw data (ratioed and averaged) on disk with the instrument state.

RAW OFFSET On Off. selects whether sampler and attenuator offsets are ON or OFF. By selecting raw offsets OFF, a full two port error correction can be performed without including the effects of the offsets. It also saves substantial time at recalls and during frequency changes. Raw offsets follow the channel coupling. This softkey is used with "Take4" mode. Refer to the examples in the programmer's guide.

Re/Im MKR. when in the smith marker menu, **Re/Im MKR** displays the values of the active marker on a Smith chart as a real and imaginary pair. The complex data is separated into its real part and imaginary part. The first marker value given is the real part M cos θ, and the second value is the imaginary part M sin θ, where M =magnitude. When in the polar marker menu, **Re/Im MKR** displays the values of the active marker as a real and imaginary pair. The complex data is separated into its real part and imaginary part. The first marker value given is the real part M cos θ, and the second value is the imaginary part M sin θ, where M = magnitude.

READ FILE TITLES. searches the directory of the disk for file names recognized as belonging to an instrument state, and displays them in the softkey labels. No more than five titles are displayed at one time. If there are more than five, repeatedly pressing this key causes the next five to be displayed. If there are fewer than five, the remaining softkey labels are blanked.

READ SEQ FILE TITLS. is a disk file directory command. Pressing this softkey will read the first six sequence titles and display them in the softkey labels. These sequences can then be loaded into internal memory. If **READ SEQ FILE TITLS** is pressed again, the next six sequence titles on the disk will be displayed. To read the contents of the disk starting again with the first sequence: remove the disk, reinsert it into the drive, and press **READ SEQ FILE TITLS**.

REAL. displays only the real (resistive) portion of the measured data on a Cartesian format. This is similar to the linear magnitude format, but can show both positive and negative values.

RECALL CAL PORT 1. Press this key after selecting the file associated with port 1 error correction for adapter removal calibration.

RECALL CAL PORT 2. Press this key after selecting the file associated with port 2 error correction for adapter removal calibration.

RECALL COLORS. recalls the previously saved modified version of the color set. This key appears only when a color set has been saved.

RECALL KEYS. accesses two recall keys which allows you to set the recall keys menu as the initial menu displayed when **Save/Recall** is pressed or select specific registers to recall.

RECALL KEYS MENU. provides access to the recall keys menu where specific registers can be recalled.

RECALL KEYS on OFF. presents the recall keys menu as the initial menu when **Save/Recall** has been pressed.

RECALL REGX. recalls the instrument state saved in register 1, 2, 3, 4, 5, 6, or 7.

RECALL STATE. when the internal disk is selected in the Save/Recall menus this key recalls the instrument state that is highlighted in the directory.

RECEIVER CAL. provides access to the Receiver Cal Menu.

RECEIV OUT CAL/OPT. manually selects the switch position for the lightwave test set, which is either in the external optical path position or the internal calibration path position. If the COUPLED SW is set to ON, the lightwave test set switch position will revert back to the default position at the end of the sweep.

REF LINE. selects the display reference line for color modification.

REF LINE [ ]. selects the reference line for printer color modification.

REFERENCE POSITION. sets the position of the reference line on the graticule of a Cartesian display, with 0 the bottom line of the graticule and 10 the top line. It has no effect on a polar or Smith display. The reference position is indicated with a small triangle just outside the graticule, on the left side for channel 1 and the right side for channel 2.

REFERENCE VALUE. changes the value of the reference line, moving the measurement trace correspondingly. In polar and Smith chart formats, the reference value is the same as the scale, and is the value of the outer circle.

REFL: FWD S11 (A/R). defines the measurement as S_{11}, the complex reflection coefficient (magnitude and phase) of the test device input.

REFL: O. configures the instrument for a measurement of the optical complex reflection coefficient (magnitude and phase) of the device under test.

REFL: REV S22 (B/R). defines the measurement as S_{22}, the complex reflection coefficient (magnitude and phase) of the test device output.

REFLECT AND LINE. measures the reflection and thru paths of the current calibration standard.

REFLECTED POWER. is used to enter the percent of reflected power for either the Fresnel reflection or the reflector. If this value is set to zero, reflected power is calculated as a Fresnel reflection using the offset index of refraction and air.

REFLECTION. leads to the reflection calibration menu.

REFLECTOR. in the Optical Kit, Modify Standards menu this key is used to modify the reflector model coefficient. in the optical reflection and transmission Response Calibration menus, this key is used to measure the reflector reference standard.

REFL SENS. initiates the response calibration for an E/O reflection sensitivity measurement.

REMOVE ADAPTER. completes the adapter removal procedure, removing the effects of the adapter being used.

RENAME FILE. allows you to change the name of a file that has already been saved.

RE-SAVE STATE. re-saves file data to an existing file or register. (The analyzer overwrites the existing file or register contents.)

RESET COLOR. resets the color being modified to the default color.

RESET MODEL. resets “k” to one and all other model coefficients to zero.

RESPONSE. When in the specify class more menu, **RESPONSE** is used to enter the standard numbers for a response calibration. This calibration corrects for frequency response in either reflection or transmission measurements, depending on the parameter being measured when a calibration is performed. (For default kits, the standard is either the open or short for reflection measurements, or the thru for transmission measurements.) When in the response cal menu, **RESPONSE** leads to the frequency response calibration. This is the simplest and fastest accuracy enhancement procedure, but should be used when extreme accuracy is not required. It effectively removes the frequency response errors of the test setup for reflection or transmission measurements. For electrical reflection measurements, the standard is either an open or a short. For optical reflection measurements, the standard is either a Fresnel reflection or a user-defined reflecting device.

RESPONSE ISOL'N. When in the specify class more menu, **RESPONSE ISOL'N** is used to enter the standard numbers for a response and isolation calibration. This calibration corrects for frequency response and directivity in reflection measurements, or frequency response and isolation in transmission measurements. When in the response and isolation menu, **RESPONSE ISOL'N** leads to the menus used to perform a response and isolation measurement calibration, for measurement of devices with wide dynamic range. This procedure effectively removes the same frequency response errors as the response calibration. In addition, it effectively removes the isolation (crosstalk) error in transmission measurements or the directivity error in reflection measurements. As well as the devices required for a simple response calibration, an isolation standard is required. For electrical measurements, the standard normally used is a broadband termination (load). For optical measurements, remove optical power from the optical input either by turning the laser off or by disconnecting the cable from the optical input.

RESPONSE & MATCH. removes frequency response errors and electrical port match errors due to reflections between: 1) The electrical output port of the analyzer and the input port of an E/O device. 2) The output port of an O/E device and the electrical input port of the analyzer.

RESTORE DISPLAY. turns off the tabular listing and returns the measurement display to the screen.

RESUME CAL SEQUENCE. eliminates the need to restart a calibration sequence that was interrupted to access some other menu. This softkey goes back to the point where the calibration sequence was interrupted. If you change any of the following settings, the calibration will become invalid: IF bandwidth, frequency range, number of points, power.

RETRACE PWR on STD. when on, causes the analyzer to retrace the sweep only over the current frequency range, and does not turn off the power during retrace, unless crossing a 20.05 GHz source band. When in STD mode, the analyzer may turn off the source power, or sweep to a lower frequency if it provides a faster retrace.

REV ISOL'N. measures the reverse isolation of the calibration standard during an enhanced response cal.

REV ISOL'N ISOL'N STD. measures the reverse isolation of the calibration standard during a full 2-port cal.

REV MATCH (Label Class). lets you enter a label for the reverse match class. The label appears during a calibration that uses this class.

REV MATCH (Specify Class). specifies which standards are in the reverse match class in the calibration kit.

REV MATCH THRU. is used to enter the standard numbers for the reverse match (thru) calibration. (For default kits, this is the thru.)

REV TRANS (Label Class). lets you enter a label for the reverse transmission class. The label appears during a calibration that uses this class.

REV TRANS (Specify Class). specifies which standards are in the reverse transmission class in the calibration kit.

REV TRANS THRU. is used to enter the standard numbers for the reverse transmission (thru) calibration. (For default kits, this is the thru.)

REVERSE: OPENS. provides access to the menu for selecting an open calibration type when the cal kit defines more than one open standard.

RIGHT LOWER. draws a quarter-page plot in the lower right quadrant of the page.

RIGHT UPPER. draws a quarter-page plot in the upper right quadrant of the page.

RIPL LIMIT on OFF. displays lines that represent the ripple limits when the ripple test is set to ON.

RIPL TEST on OFF. turns ripple testing on or off. When ripple testing is on, the analyzer sets the lower ripple limit line at the lowest amplitude point within the frequency band and sets the upper limit line at the user-specified amplitude above. If the trace data remains at or below the upper limit line, that portion of the ripple test passes. If the trace data rises above the upper limit line within the frequency band, the test fails. Data within each frequency band is compared with the defined ripple limit of the band. The ripple test checks each frequency band using this method. A maximum of 12 frequency bands can be tested on each channel. These bands may overlap in frequency. If all of the channel's frequency bands pass the ripple test, the analyzer displays a pass message. If the test passed, a message is displayed in orange text in the upper right portion of the LCD. An example of this message is: RIPL1 PASS, where the "1" indicates the channel where the ripple test is performed. If the ripple test does not pass, a fail message is displayed in red text. An example of this message is RIPL1 FAIL.

RIPL VALUE [ ]. displays the ripple value of the selected frequency band. The ripple value can be displayed in two ways or turned off. Selecting OFF removes the displayed ripple value from the display. Selecting ABSOLUTE or MARGIN displays the ripple value. The ripple value is preceded on the display by an indicator of the selected band. For example, when the ripple value is preceded by "B2", this indicates that the ripple value shown is for Band 2. The frequency band indicator and ripple value are displayed in the same color as the pass/fail message for the overall ripple test. When ABSOLUTE is selected, the display shows the absolute ripple of the data trace within the frequency band. When MARGIN is selected, the display shows the difference between the maximum allowable ripple and the absolute ripple value within the frequency band. When the margin value is preceded by a plus sign (+), this indicates that the ripple within the selected frequency band is passing by the value shown. When the margin value is preceded by a negative sign (–), this indicates that the ripple within the selected band is failing by the value shown.

RIPL VALUE BAND. selects a frequency band to display the ripple value. When **RIPL VALUE [ ]** is set to the absolute or margin choices, this softkey selects the ripple measurement for the selected frequency band.

RIPPLE LIM LINES. selects ripple limit line trace on the display color modification.

RIPPLE LIMIT. selects the ripple limit line choice. This selection leads to menus used to define ripple limits or specifications with which to compare a test device. Refer to the "Using Ripple Limits to Test a Device" section in the "Making Measurements" chapter of the user's guide.

ROUND SECONDS. resets the seconds counter to zero in real-time clock.

S PARAMETERS. presents the S-parameter menu, which is used to define the input ports and test set direction for S-parameter measurements.

S11 1-PORT. provides a measurement calibration for reflection-only. Measurements of one-port devices or properly terminated two-port devices, at port 1 of an S-parameter test set.

S11A. is used to enter the standard numbers for the first class required for an S_{11} 1-port calibration. (For default cal kits, this is the open.)

S11B. is used to enter the standard numbers for the second class required for an S_{11} 1-port calibration. (For default cal kits, this is the short.)

S11C. is used to enter the standard numbers for the third class required for an S_{11} 1-port calibration. (For default kits, this is the load.)

S11 REFL SHORT. measures the short circuit TRL/LRM calibration data for PORT 1.

S11/21 ENH. RESP. provides an S11 and S21 enhanced response calibration (forward direction). Enhanced response generates a 1-port cal for S11 and an improved calibration over the response cal for S21 .

S22 1-PORT. provides a measurement calibration for reflection-only. Measurements of one-port devices or properly terminated two-port devices, at port 2 of an S-parameter test set.

S22/12 ENH. RESP. provides an S22 and S12 enhanced response calibration (reverse direction). Enhanced response generates a 1-port cal for S22 and an improved calibration over the response cal for S12 .

S22A. is used to enter the standard numbers for the first class required for an S_{22} 1-port calibration. (For default cal kits, this is the open.)

S22B. is used to enter the standard numbers for the second class required for an S_{22} 1-port calibration. (For default cal kits, this is the short.)

S22C. is used to enter the standard numbers for the third class required for an S_{22} 1-port calibration. (For default kits, this is the load.)

S22 REFL SHORT. measures the short circuit TRL/LRM calibration data for PORT 2.

SAMPLR COR on OFF. selects whether sampler correction is on or off.

SAVE COLORS. saves the modified version of the color set.

SAVE FILE. saves the display information to the disk drive. The type of information saved is dependent on the FILETYPE selection. The FILETYPE selection can either be graphic or text.

SAVE FILE FORMATS. accesses the save file menu which allows you to save the display information to the disk drive as either graphic or textual information.

SAVE STATE. saves file data in the next available register if you are saving to internal memory, or saves the data to a disk.

SAVE USER KIT. stores the user-modified or user-defined kit into memory, after it has been modified.

SAVE USING ASCII. selects ASCII format for data storage to disk.

SAVE USING BINARY. selects binary format for data storage.

Save/Recall. provides access to all the menus used for saving and recalling instrument states in internal memory and for storing to, or loading from the internal or external disk. This includes the menus used to define titles for internal registers and external disk files, to define the content of disk files, to initialize disks for storage, and to clear data from the registers or purge files from disk.

SCALE/DIV. changes the response value scale per division of the displayed trace. In polar and Smith chart formats, this refers to the full scale value at the outer circumference, and is identical to reference value.

SCALE PLOT [ ]. toggles between two selections for plot scale, FULL and GRAT.

SCALE PLOT [FULL]. is the normal scale selection for plotting on blank paper. It includes space for all display annotations such as marker values, stimulus values, etc. The entire display fits within the user-defined boundaries of P1 and P2 on the plotter, while maintaining the exact same aspect ratio as the display.

SCALE PLOT [GRAT]. expands or reduces the horizontal and vertical scale so that the lower left and upper right graticule corners exactly correspond to the user-defined P1 and P2 scaling points on the plotter. This is convenient for plotting on preprinted rectangular or polar forms (for example, on a Smith Chart).

Scale Ref. makes scale per division the active function. A menu is displayed that is used to modify the vertical axis scale and the reference line value and position. In addition this menu provides electrical delay offset capabilities for adding or subtracting linear phase to maintain phase linearity.

SEARCH LEFT. searches the trace for the next occurrence of the target value to the left.

SEARCH RIGHT. searches the trace for the next occurrence of the target value to the right.

SEARCH: MAX. moves the active marker to the maximum point on the trace.

SEARCH: MIN. moves the active marker to the minimum point on the trace.

SEARCH: OFF. turns off the marker search function.

SEARCH: TARGET. searches for the user-specified target point on the trace.

SEGMENT. specifies which limit segment in the table is to be modified. A maximum of three sets of segment values are displayed at one time, and the list can be scrolled up or down to show other segment entries. Use the entry block controls to move the pointer > to the required segment number. The indicated segment can then be edited or deleted. If the table of limits is designated “EMPTY,” new segments can be added using the **ADD** or **EDIT** softkey.

SEGMENT: CENTER. sets the center frequency of a subsweep in a list frequency sweep.

SEGMENT IF BW. enters the IF bandwidth for the active segment in a swept list table. This key is disabled if is set to OFF.

SEGMENT POWER. enters absolute power values in the swept list table. The power values are restricted to the current power range setting. If port power is uncoupled, power applies to the currently selected port, otherwise it applies to both ports. (The list table only displays one port's power values at time due to limited display area.) To set the alternate port's power level, you must exit the edit list menus, select a measurement that activates the alternate port, and then re-enter the edit list menus. This key is disabled if **LIST POWER** is set to **OFF**.

SEGMENT: SPAN. sets the frequency or power span of a subsweep about a specified center frequency.

SEGMENT: START. sets the start frequency of a subsweep.

SEGMENT: STOP. sets the stop frequency of a subsweep.

SEL QUAD. leads to the select quadrant menu, which provides the capability of drawing quarter-page plots.

SELECT DEFAULTS. leads to the default menu.

SELECT DISK. provides access to the select disk menu.

SELECT LETTER. The active entry area displays the letters of the alphabet, digits 0 through 9, and mathematical symbols. To define a title, rotate the knob until the arrow ↑ points at the first letter, then press **SELECT LETTER**. Repeat this until the complete title is defined, for a maximum of 50 characters. As each character is selected, it is appended to the title at the top of the graticule.

Seq. accesses a series of sequencing menus. These allow you to create, modify, and store up to 6 sequences which can be run automatically.

SEQUENCE 1 SEQ1. activates editing mode for the segment titled "SEQ1" (default title).

SEQUENCE 2 SEQ2. activates editing mode for the segment titled "SEQ2" (default title).

SEQUENCE 3 SEQ3. activates editing mode for the segment titled "SEQ3" (default title).

SEQUENCE 4 SEQ4. activates editing mode for the segment titled "SEQ4" (default title).

SEQUENCE 5 SEQ5. activates editing mode for the segment titled "SEQ5" (default title).

SEQUENCE 6 SEQ6. activates editing mode for the segment titled "SEQ6" (default title).

SEQUENCE FILENAMING. accesses a file naming menu which is used to automatically increment or decrement the name of a file that is generated by the network analyzer during a SEQUENCE.

SERVICE MENU. leads to a series of service and test menus.

SERVICE MODES. a collection of common modes used for troubleshooting.

SET ADDRESSES. goes to the address menu, which is used to set the GPIB address of the analyzer, and to display and modify the addresses of peripheral devices in the system, such as the printer, plotter, disk drive, and power meter.

SET CLOCK. allows you to set the analyzer's internal clock.

SET DAY. allows you to set the day in the analyzer's internal clock.

SET HOUR. allows you to set the hour in the analyzer's internal clock.

SET MINUTES. allows you to set the minutes in the analyzer's internal clock.

SET MONTH. allows you to set the month in the analyzer's internal clock.

SET REF: REFLECT. sets the measurement reference plane to the TRL/LRM REFLECT standard.

SET REF: THRU. sets the measurement reference plane to the TRL/LRM THRU standard.

SET YEAR. allows you to set the year in the analyzer's internal clock.

SET Z0. sets the characteristic impedance used by the analyzer in calculating measured impedance with Smith chart markers and conversion parameters. Characteristic impedance must be set correctly before calibration procedures are performed.

SETUP A. sets up four-graticule, four-channel display as described in the **4 PARAM HELP KEYS** menu. All four graticules are in log format.

SETUP B. sets up two-graticule, four-channel display as described in the **4 PARAM HELP KEYS** menu.

SETUP C. sets up single-graticule, four-channel display as described in the **4 PARAM HELP KEYS** menu.

SETUP D. sets up four-graticule, four-channel display as described in the **4 PARAM HELP KEYS** menu. Two of the graticules are in Smith chart format with the other two in log format.

SETUP E. sets up two-graticule, four-channel display as described in the **4 PARAM HELP KEYS** menu.

SETUP F. sets up three-graticule, three-channel display as described in the **4 PARAM HELP KEYS** menu.

OPEN (F). for cal kits with different models for male and female test port standards, this selects the short model for a female test port. Note that the sex of a calibration standard always refers to the test port.

OPEN (M). for cal kits with different models for male and female test port standards, this selects the short model for a male test port. Note that the sex of a calibration standard always refers to the test port.

SHORT. short calibration standard.

SHOW MENUS. used to display a specific menu prior to a pause statement in a sequence.

SINGLE. takes one sweep of data and returns to the hold mode.

SINGLE POINT. sets the limits at a single stimulus point. If limit lines are on, the upper limit value of a single point limit is displayed as ∨ and the lower limit is displayed as ∧. A limit test at a single point not terminating a flat or sloped line tests the nearest actual measured data point. A single point limit can be used as a termination for a flat line or sloping line limit segment. When a single point terminates a sloping line or when it terminates a flat line and has the same limit values as the flat line, the single point is not displayed as ∨ and ∧. The indication for a single point segment in the displayed table of limits is SP.

SINGLE SEG SWEEP. enables a measurement of a single segment of the frequency list, without loss of calibration. The segment to be measured is selected using the entry block. In single segment mode, selecting a measurement calibration will force the full list sweep before prompting for calibration standards. The calibration will then be valid for any single segment. If an instrument state is saved in memory with a single-segment trace, a recall will re-display that segment while also recalling the entire list.

SLIDING. defines the load as a sliding load. When such a load is measured during calibration, the analyzer will prompt for several load positions, and calculate the ideal load value from it.

SLOPING LINE. defines a sloping limit line segment that is linear with frequency or other stimulus value, and is continuous to the next stimulus value and limit. If a sloping line is the final segment, it becomes a flat line terminated at the stop stimulus. A sloping line segment is indicated as SL on the displayed table of limits.

SMITH CHART. displays a Smith chart format. This is used in reflection measurements to provide a readout of the data in terms of impedance. It provides information such as the reflection coefficient and input/output impedance of the DUT.

SMITH MKR MENU. leads to a menu of special markers for use with a Smith chart format.

SMOOTHING APERTURE. lets you change the value of the smoothing aperture as a percent of the span. When smoothing aperture is the active function, its value in stimulus units is displayed below its percent value in the active entry area. Smoothing aperture is also used to set the aperture for group delay measurements. Note that the displayed smoothing aperture is not the group delay aperture unless smoothing is on.

SMOOTHING on OFF. turns the smoothing function on or off for the active channel. When smoothing is on, the annotation “Smo” is displayed in the status notations area. Use this key to restore power after a power interruption. ON returns the source power to its original setting, while OFF sets the source to the minimum power level of the analyzer.

SOURCE TUNE OFF. provides service access to pretune the source, without using the phase-locked loop.

SPACE. inserts a space in the title.

Span. is used, along with the **Center** key, to define the frequency range of the stimulus. When the **Span** key is pressed, it becomes the active function. The value is displayed in the active entry area, and can be changed with the knob, step keys, or numeric keypad.

SPAN. sets the frequency or power span of a subsweep about a specified center frequency.

SPECIAL FUNCTIONS. presents the special function menu.

SPECIFY CLASS. leads to the specify class menu. After the standards are modified, use this key to specify a class to consist of certain standards.

SPECIFY CLASS DONE. finishes the specify class function and returns to the modify cal kit menu.

SPECIFY OFFSET. allows additional specifications for a user-defined standard. Features specified in this menu are common to all five types of standards.

SPLIT DISP 1X 2X 4X. toggles between a full-screen single graticule display or two-, three-, or four-graticule, multiple-channel display. Works with **DUAL CHAN on OFF** to determine the number of channels displayed.

STANDARD DONE. returns to the define standard menu.

Start. is used to define the start frequency of a frequency range. When the **Start** key is pressed it becomes the active function. The value is displayed in the active entry area, and can be changed with the knob, step keys, or numeric keypad.

STATS. calculates and displays the mean, standard deviation, and peak-to-peak values of the section of the displayed trace between the active marker and the delta reference marker. If there is no delta reference, the statistics are calculated for the entire trace. A convenient use of this feature is to find the peak-to-peak value of passband ripple without searching separately for the maximum and minimum values. The statistics are absolute values: the delta marker here serves to define the span. For polar and Smith chart formats, the statistics are calculated using the first value of the complex pair (magnitude, real part, resistance, or conductance).

STD OFFSET DONE. is used to end the specify offset sequence.

STD TYPE: is used to specify the type of calibration device being measured.

STD TYPE: ARBITRARY\IMPEDANCE. defines the standard type to be a load, but with an arbitrary impedance (different from system Z0).

STD TYPE: DELAY/THRU. defines the standard type as a transmission line of specified length, for calibrating transmission measurements.

STD TYPE: LOAD. defines the standard type as a load (termination). Loads are assigned a terminal impedance equal to the system characteristic impedance ZO, but delay and loss offsets may still be added. If the load impedance is not ZO, use the arbitrary impedance standard definition.

STD TYPE: OPEN. defines the standard type as an open used for calibrating reflection measurements. Opens are assigned a terminal impedance of infinite Ωs, but delay and loss offsets may still be added. Pressing this key also brings up a menu for defining the open, including its capacitance.

STD TYPE: SHORT. defines the standard type as a short used for calibrating reflection measurements. Shorts are assigned a terminal impedance of 0 Ωs, but delay and loss offsets may still be added.

STEP SIZE. is used to specify the subsweep in frequency steps instead of number of points. Changing the start frequency, stop frequency, span, or number of points may change the step size. Changing the step size may change the number of points and stop frequency in start/stop/step mode or the frequency span in center/span/step mode. In each case, the frequency span becomes a multiple of the step size.

STIMULUS VALUE. sets the starting stimulus value of a segment, using entry block controls. The ending stimulus value of the segment is defined by the start of the next line segment. No more than one segment can be defined over the same stimulus range.

STIMULUS OFFSET. adds or subtracts an offset in stimulus value. This allows limits already defined to be used for testing in a different stimulus range. Use the entry block controls to specify the offset required.

Stop. is used to define the stop frequency of a frequency range. When the **Stop** key is pressed, it becomes the active function. The value is displayed in the active entry area, and can be changed with the knob, step keys, or numeric keypad.

STOP. sets the stop frequency of a subsweep.

STORE SEQ TO DISK. presents the store sequence to disk menu with a list of sequences that can be stored.

Menu. provides access to a series of menus which are used to define and control all stimulus functions other than start, stop, center, and span. Operating parameters such as power, sweeptime, trigger condition, and number of points are accessible through this hardkey.

SWEEP TIME [ ]. toggles between automatic and manual sweep time.

SWEEP TYPE MENU. presents the sweep type menu, where one of the available types of stimulus sweep can be selected.

SWR. reformats a reflection measurement into its equivalent SWR (standing wave ratio) value. SWR is equivalent to $(1+\rho)/(1-\rho)$, where ρ is the magnitude of the reflection coefficient. Note that the results are valid only for reflection measurements. If the SWR format is used for measurements of S_{21} or S_{12}, the results are not valid.

System. presents the system menu. It allows to set the instrument mode and to access the configure, limit and service menus.

SYSTEM CONTROLLER. is the mode used when peripheral devices are to be used and there is no external controller. In this mode, the analyzer can directly control peripherals (plotter, printer, disk drive, or power meter). System controller mode must be set in order for the analyzer to access peripherals from the front panel to plot, print, store on disk, or perform power meter functions, if there is no other controller on the bus. The system controller mode can be used without knowledge of GPIB programming. However, the GPIB address must be entered for each peripheral device. This mode can only be selected manually from the analyzer's front panel, and can be used only if no active computer controller is connected to the system through GPIB. If you try to set system controller mode when another controller is present, the message `ANOTHER SYSTEM CONTROLLER ON GPIB` is displayed. Do not attempt to use this mode for programming.

TAKE CAL SWEEP. Each data point is measured during the initial sweep and the correction data is placed in the power meter correction table. This provides data usable in the **ONE SWEEP** mode.

TAKE RCVR CAL SWEEP. executes a receiver calibration.

TALKER/LISTENER. is the mode normally used for remote programming of the analyzer. In this mode, the analyzer and all peripheral devices are controlled from the external controller. The controller can command the analyzer to talk, and the plotter or other device to listen. The analyzer and peripheral devices cannot talk directly to each other unless the computer sets up a data path between them. This mode allows the analyzer to be either a talker or a listener, as required by the controlling computer for the particular operation in progress. A talker is a device capable of sending out data when it is addressed to talk. There can be only one talker at any given time. The analyzer is a talker when it sends information over the bus. A listener is a device capable of receiving data when it is addressed to listen. There can be any number of listeners at any given time. The analyzer is a listener when it is controlled over the bus by a computer.

TARGET. makes target value the active function, and places the active marker at a specified target point on the trace. The default target value is –3 dB. The target menu is presented, providing search right and search left options to resolve multiple solutions. For relative measurements, a search reference must be defined with a delta marker or a fixed marker before the search is activated.

TARGET VALUE. sets the value for target searches, without activating a search.

TERMINAL IMPEDANCE. is used to specify the (arbitrary) impedance of the standard, in Ωs.

TEST OPTIONS. is used to set configurations before running the service tests.

TESTPORT 1 2. is used to direct the RF power to port 1 or port 2. (For non-S parameter inputs only.)

TESTSET I/O FWD. is used to support specialized test sets, such as a test set that measures duplexers. It allows you to set three bits (D1, D2, and D3) to a value of 0 to 7, and outputs it as binary from the rear panel test set connector. It tracks the coupling flag, so if coupling is on, and FWD channel 1 is the active channel, FWD channel 2 will be set to the same value.

TESTSET I/O REV. is used to support specialized test sets, such as a test set that measures duplexers. It allows you to set three bits (D1, D2, and D3) to a value of 0 to 7, and outputs it as binary from the rear panel test set connector. It tracks the coupling flag, so if coupling is on, and REV channel 1 is the active channel, REV channel 2 will be set to the same value.

TESTSET SW CONTINUOUS. toggles the internal solid state switch from a hold mode, to a continuously switching mode, or to a number of sweeps mode when full 2-port correction is enabled. Use for fast 2-port calibration.

TESTS. presents the service test menu.

TEXT. selects all the non-data display text for color modification. For example: operating parameters.

TEXT [ ]. brings up the print color definition menu. The default color for text is black.

TEXT FMT [ ]. sets the format of the text file when **FILETYPE: TEXT** is selected. The only text selection currently available is the comma separated values (CSV) format.

THRU. starts the measurement of a calibration standard used for transmission measurements. This standard directly connects between the analyzer output and input ports.

THRUS. starts the measurement of calibration standards used for transmission measurements. There is one cable that directly connects between the analyzer electrical output and input ports (PORT 1 and PORT 2). There is also one cable that directly connects between the analyzer optical output and input ports (OPTICAL OUTPUT and OPTICAL RECEIVER).

THRU/RCVR. starts the frequency response calibration of the instrument when in the E/O mode. RCVR stands for receiver, and implies that the instrument will use the internally stored calibration data for the internal optical receiver. Use this type of calibration when the DUT can be connected directly to the optical receiver input port, or when the loss and delay of an optical cable are of no concern. For more information, refer to chapter 4 of the user's guide.

THRU/SRC. starts the frequency response calibration of the instrument when in the O/E (port 2) mode. SRC stands for source, and implies that the internally stored calibration data for the optical source and modulator will be used to compute the calibration coefficients. Use this type of calibration when the DUT can be connected directly to the OPTICAL OUTPUT, or when the loss and delay of an optical cable are of no concern. For more information, refer to chapter 4 of the user's guide.

THRU THRU. measures all four S-parameters in a TRL/LRM calibration.

TIME STAMP on OFF. turns the time stamp function on or off.

TINT. adjusts the continuum of hues on the color wheel of the chosen attribute. Refer to the section on adjusting the display color in the "Making Measurements" chapter of the user's guide for an explanation of using this softkey for color modification of display attributes.

TITLE. presents the title menu in the softkey labels area and the character set in the active entry area. These are used to label the active channel display. A title more menu allows up to four values to be included in the printed title active entry, active marker amplitude, limit test results, and loop counter value.

TITLE SEQUENCE. allows the operator to rename any sequence with an eight character title. All titles entered from the front panel must begin with a letter, and may only contain letters and numbers. A procedure for changing the title of a sequence is provided at the beginning of this chapter.

TITLE TO MEMORY. moves the title string data obtained with the **P MTR/GPIB TO TITLE** command into a data array. **TITLE TO MEMORY** strips off leading characters that are not numeric, reads the numeric value, and then discards everything else. The number is converted into analyzer internal format, and is placed into the real portion of the memory trace at: Display point = total points – 1 – loop counter. If the value of the loop counter is zero, then the title number goes in the last point of memory. If the loop counter is greater than or equal to the current number of measurement points, the number is placed in the first point of memory. A data to memory command must be executed before using the title to memory command.

TITLE TO P MTR/GPIB. outputs a title string to any device with an GPIB address that matches the address set with the analyzer **Local, SET ADDRESSES, ADDRESS: P MTR/GPIB** commands. This softkey is generally used for two purposes: sending a title to a printer when a CR-LF is not desired and sending commands to an GPIB device.

TITLE TO PERIPHERAL. outputs a title string to any device with an GPIB address that matches the address set with the analyzer **Seq, SPECIAL FUNCTIONS, PERIPHERAL GPIB ADDR** commands. This softkey is generally used for two purposes: sending a title to a printer when a CR-LF is not desired and sending commands to an GPIB device.

TITLE TO PRNTR/GPIB. outputs a title string to any device with an GPIB address that matches the address set with the analyzer **Local, SET ADDRESSES, ADDRESS: PRINTER** commands. This softkey is generally used for two purposes: sending a title to a printer for data logging or documentation purposes and sending commands to a printer or other GPIB device.

TRACKING on OFF. is used in conjunction with other search features to track the search with each new sweep. Turning tracking on makes the analyzer search every new trace for the specified target value and put the active marker on that point. If bandwidth search is on, tracking searches every new trace for the specified bandwidth, and repositions the dedicated bandwidth markers.

When tracking is off, the target is found on the current sweep and remains at the same stimulus value regardless of changes in trace response value with subsequent sweeps. A maximum and a minimum point can be tracked simultaneously using two channels and uncoupled markers.

TRANS: O/O. configures the instrument for a measurement of the optical complex forward transmission coefficient (magnitude and phase) of the device under test.

TRANS: E/O. configures the instrument for a measurement of the electrical-to-optical complex forward transmission coefficient (magnitude and phase) of the device under test. This is also referred to as the modulation transfer or response function of the device under test.

TRANS: O/E PORT 1. configures the instrument for a measurement of the electrical-to-optical complex forward transmission coefficient (magnitude and phase) of the device under test through port 1. This is also referred to as the demodulation transfer or response function of the device under test.

TRANS: O/E PORT 2. configures the instrument for a measurement of the electrical-to-optical complex forward transmission coefficient (magnitude and phase) of the device under test through port 2. This is also referred to as the demodulation transfer or response function of the device under test.

TRANS: FWD S21 (B/R). defines the measurement as S_{21}, the complex forward transmission coefficient (magnitude and phase) of the test device.

TRANS: REV S12 (A/R). defines the measurement as S_{12}, the complex reverse transmission coefficient (magnitude and phase) of the test device.

TRANSMISSION. leads to the transmission menu.

TRIGGER MENU. presents the trigger menu, which is used to select the type and number of the sweep trigger.

TRIGGER: TRIG OFF. turns off external trigger mode.

TRL 3.5 mm 85052C. selects the 85052C cal kit.

TRL*/LRM* 2-PORT. leads to the TRL*/LRM* 2-port calibration menu.

TRL/LRM OPTION. selects the TRL/LRM Option Menu, under the modify cal kit menu.

TRL LINE OR MATCH. is used to enter the standard numbers for the TRL LINE or MATCH class.

TRL THRU. is used to enter the standard numbers for the TRL THRU class.

TRL REFLECT. is used to enter the standard numbers for the TRL REFLECT class.

TTL OUT HIGH. sets the TTL output (TEST SEQ BNC) on the back of the analyzer high.

TTL OUT LOW. sets the TTL output (TEST SEQ BNC) on the back of the analyzer low.

TUNED RECEIVER. sets the analyzer to function as a tuned receiver only, disabling the source.

UNCOUPLED. allows the marker stimulus values to be controlled independently on each channel.

UPPER LIMIT. sets the upper limit value for the start of the segment. If a lower limit is specified, an upper limit must also be defined. If no upper limit is required for a particular measurement, force the upper limit value out of range (for example +500 dB). When **UPPER LIMIT** or **LOWER LIMIT** is pressed, all the segments in the table are displayed in terms of upper and lower limits, even if they were defined as delta limits and middle value. If you attempt to set an upper limit that is lower than the lower limit, or vice versa, both limits will be automatically set to the same value.

USE PASS CONTROL. lets you control the analyzer with the computer over GPIB as with the talker/listener mode, and also allows the analyzer to become a controller in order to plot, print, or directly access an external disk. During this peripheral operation, the host computer is free to perform other internal tasks that do not require use of the bus (the bus is tied up by the analyzer during this time). The pass control mode requires that the external controller is programmed to respond to a request for control and to issue a take control command. When the peripheral operation is complete, the analyzer passes control back to the computer. Refer to the GPIB programming chapters in the programmer's guide for more information. In general, use the talker/listener mode for programming the analyzer unless direct peripheral access is required.

USE SENSOR A/B. selects the A or B power sensor calibration factor list for use in power meter calibration measurements.

USER. is used to select the preset condition defined by the user.

USER KIT. is used to define kits other than those offered by Agilent Technologies.

USER SETTINGS. selects a menu of user settings, including preset settings that can be changed by the user.

VELOCITY FACTOR. enters the velocity factor used by the analyzer to calculate equivalent electrical length in distance-to-fault measurements using the time domain option. Values entered should be less than 1. Velocity factor is the ratio of the velocity of wave propagation in a coaxial cable to the velocity of wave propagation in free space. Most cables have a relative velocity of about 0.66 the speed in free space. This velocity depends on the relative permittivity of the cable dielectric (ε_r) as: $$Velocity\ Factor = \frac{1}{\sqrt{\varepsilon_r}}$$

VERIFY INSTRUMENT. allows you to run a routine that verifies the analyzer by measuring a device from the N1011A verification kit and comparing the measured data to data provided in the kit.

VOLUME NUMBER. specifies the number of the disk volume to be accessed. In general, all 3.5 inch floppy disks are considered one volume (volume 0). For hard disk drives, a switch in the disk drive must be set to define the number of volumes on the disk. (This function only applies to external GPIB disks.)

WAIT x. pauses the execution of subsequent sequence commands for x number of seconds. Terminate this command with **x1**. Entering a 0 in wait x causes the instrument to wait for prior sequence command activities to finish before allowing the next command to begin. The wait 0 command only affects the command immediately following it, and does not affect commands later in the sequence.

WARNING. selects the display warning annotation for color modification.

WARNING [ ]. brings up the color definition menu. The warning annotation default color is black.

WAVEGUIDE. defines the standard (and the offset) as rectangular waveguide. This causes the analyzer to assume a dispersive delay. See **OFFSET DELAY**.

WAVEGUIDE DELAY. applies a non-linear phase shift for use with electrical delay which follows the standard dispersive phase equation for rectangular waveguide. When **WAVEGUIDE DELAY** is pressed, the active function becomes the WAVEGUIDE CUTOFF frequency, which is used in the phase equation. Choosing a Start frequency less than the Cutoff frequency results in phase errors.

WIDTH VALUE. is used to set the amplitude parameter (for example 3 dB) that defines the start and stop points for a bandwidth search. The bandwidth search feature analyzes a bandpass or band reject trace and calculates the center point, bandwidth, and Q (quality factor) for the specified bandwidth. Bandwidth units are the units of the current format.

WIDTHS on OFF. turns on the bandwidth search feature and calculates the center stimulus value, bandwidth, and Q of a bandpass or band reject shape on the trace. The amplitude value that defines the pass band or reject band is set using the **WIDTH VALUE** softkey. Four markers are turned on, and each has a dedicated use. Marker 1 is a starting point from which the search is begun. Marker 2 goes to the bandwidth center point. Marker 3 goes to the bandwidth cutoff point on the left, and Marker 4 to the cutoff point on the right. If a delta marker or fixed marker is on, it is used as the reference point from which the bandwidth amplitude is measured. For example, if marker 1 is the delta marker and is set at the passband maximum, and the width value is set to –3 dB, the bandwidth search finds the bandwidth cutoff points 3 dB below the maximum and calculates the 3 dB bandwidth and Q. If marker 2 (the dedicated bandwidth center point marker) is the delta reference marker, the search finds the points 3 dB down from the center. If no delta reference marker is set, the bandwidth values are absolute values.

x1. is used to terminate basic units: dB, dBm, Hz, dB/GHz, degrees, or seconds. It may also be used to terminate unitless entries such as averaging factor.

XMIT CNTRL [ ]. toggles the PLOTTER/PRINTER serial port data transmit control mode between the Xon-Xoff protocol handshake and the DTR-DSR (data terminal ready-data set ready) hardwire handshake.

Y: REFL. converts reflection data to its equivalent admittance values.

Y: TRANS. converts transmission data to its equivalent admittance values.

Z: REFL. converts reflection data to its equivalent impedance values.

Z: TRANS. converts transmission data to its equivalent impedance values.

5

Operating Concepts

Operating Concepts

Operating Concepts

In this chapter, you can find basic information about instrument operation and measurement techniques you can use with your Lightwave Component Analyzer.

The first two sections of this chapter cover different types of devices you can measure, and basic analyzer operation and functions. Following these discussions are sections explaining important details of specific analyzer functions.

The remaining sections explain measurement enhancement techniques, calibration, and GPIB operation.

Types of Devices You Can Measure

The lightwave component analyzer can measure four types of devices as a function of frequency. These devices are categorized according to their input and output signals: electrical or optical. The lightwave component analyzer can be thought of as both an optical and an electrical measuring instrument. The types of devices the analyzer can measure are defined as follows:

- Optical-to-Optical (O/O) device: This is any device with an optical input and optical output signal. This includes fiber cables, fiber cable connectors, couplers, splitters, tees, and so on.
- Electrical-to-Optical (E/O) device: This is any device with an electrical input signal and an optical output signal. This includes E/O modulators or sources (often called E/O converters), directly modulatable laser sources, transmitters, and optical modulators.
- Optical-to-Electrical (O/E) device: This is any device with an optical input signal and an electrical output signal. This includes O/E demodulators or receivers (often call O/E converters), lightwave receivers, and photo-diodes.
- Electrical-to-Electrical (E/E) device: This is any device with an electrical input signal and an electrical output signal. This includes any type of device that is typically measured on an RF or microwave network analyzer.

Lightwave Component Analyzer Operation

For either optical or electrical measurements, the operation of the lightwave component analyzer is similar to an RF or microwave network analyzer. For electrical measurements the signal is split. The reference signal goes directly into the analyzer and the test signal is applied to the device. The signal transmitted through the device or the signal reflected back from the device's input is measured. The ratio of the transmitted or reflected signal to the reference signal is taken. The result is displayed on the analyzer display as a trace value, where the X-axis is frequency and the Y-axis is magnitude.

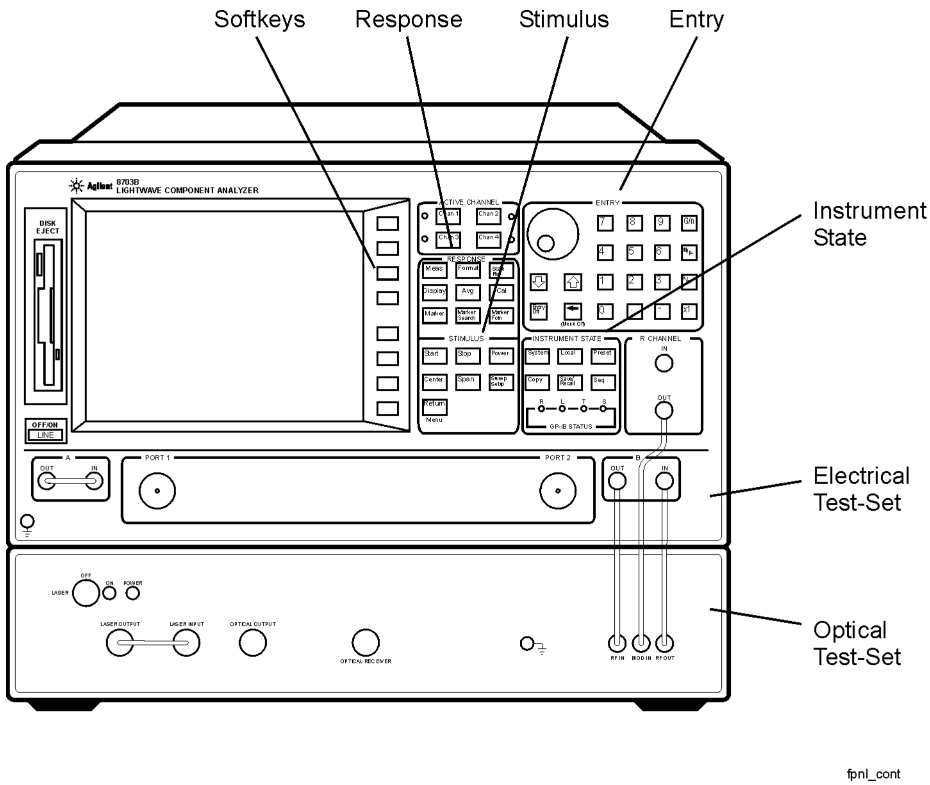
For optical measurements, the same sequence is followed except that the electrical signal is used to modulate a lightwave carrier. After being applied to the test device, the optical response signal is demodulated. The response signal is the demodulated electrical signal.

In order to make these ratio measurements, an electrical source, a lightwave source, a lightwave receiver, and an electrical receiver are required.

Front Panel System Operation

Using the front panel, you can choose a specific measurement, control the source, control how the data is taken and displayed. The front panel keys are divided into functional groups as shown in the figure below.

Figure 5-1. Front Panel Controls



Softkeys

The function of this group of keys is not fixed but is determined prior to their use by keys in the STIMULUS, RESPONSE, and INSTRUMENT STATE function blocks. The key labels appear on the analyzer display.

Stimulus

This group of keys controls all functions related to the analyzer's internal microwave source, including output power levels and power sweep, frequency range, sweep time, and number of measurement data points measured by the receiver. The stimulus signal modulates the lightwave source in the test set or an E/O or E/E device.

Response

This group of keys controls all receiver functions. This includes the measurement parameters, display format (log magnitude, phase, delay, polar), type of scale, averaging, marker functions, and measurement calibration.

Instrument State

These keys control channel-independent system functions including instrument preset, plotter and printer control, memory save and recall (internal or external disk), and limit testing.

Output Power

Understanding the Power Ranges

The built-in synthesized source contains a programmable step attenuator that allows you to directly and accurately set power levels in twelve different power ranges. Each range has a total span of 20 dB. The twelve ranges cover the instrument's full operating range. In addition, some amount of overrange and underrange is permitted beyond the stated limits. Performance outside of the range limits varies from one analyzer to another and is not specified. A power range can be selected either manually or automatically.

Automatic mode

If you select **PWR RANGE AUTO,** you can enter any power level within the total operating range of the instrument and the source attenuator will automatically switch to the corresponding range.

Each range overlaps its adjacent ranges by 15 dB, therefore, certain power levels are designated to cause the attenuator to switch to the next range so that optimum (leveled) performance is maintained. These transition points exist at –10 dB from the top of a range and at +5 dB from the bottom of a range. This leaves 10 dB of operating range. By turning the analyzer front panel knob with **PORT POWER,** being the active function, you can hear the attenuator switch as these transitions occur. See Chapter 1, "Specifications and Regulatory Information" for the analyzer's power limits.

Manual mode

If you select **PWR RANGE MAN,** you must first enter the power ranges menu and manually select the power range that corresponds to the power level you want to use. This is accomplished by pressing the **POWER RANGES,** softkey and then selecting one of the 12 available ranges. The active power will always be reset to be within this range. In this mode, you will be able to select power levels above or below the range limits. The factory limits on setting power level are +6 dB above the maximum range power and –12 dB below the minimum range power. Typical performance for power overrange is 2 dB above the maximum (more at lower frequencies and less at higher frequencies) and typical under range is 12 dB. An under-range condition may cause a phase lock lost message to be displayed.

When a calibration is active, the power range selection is switched from auto to manual mode, and `PRm` appears on the display. This feature is necessary to maintain accuracy once a measurement calibration is activated.

NOTE After measurement calibration, you can change the power within a range and still maintain nearly full accuracy. In some cases better accuracy can be achieved by changing the power within a range. It can be useful to set different power levels for calibration and measurement to minimize the effects of sampler compression or noise floor. If you decide to switch power ranges, the calibration accuracy is degraded and accuracy is no longer specified. However, the analyzer leaves the correction *on*. The annotation `CΔ` will be displayed whenever you change the power after calibration.

Power Coupling Options

There are two methods you can use to couple and uncouple power levels with the analyzer:

- channel coupling

- port coupling

By uncoupling the channel powers, you effectively have two separate sources. Uncoupling the test ports allows you to have different power levels on each port.

Channel coupling

CH PWR [COUPLED], toggles between coupled and uncoupled channel power. With the channel power coupled, the power levels are the same on each channel. With the channel power uncoupled, you can set different power levels for each channel. For the channel power to be uncoupled, the other channel stimulus functions must also be uncoupled (**COUPLED CH OFF,**).

Test port coupling

PORT PWR [COUPLED], toggles between coupled and uncoupled test ports. With the test ports coupled, the power level is the same at each port. With the ports uncoupled, you can set a different power level at each port. This can be useful, for example, if you want to simultaneously perform a gain and reverse isolation measurement on a high-gain amplifier using the dual channel mode to display the results. In this case, you would want the power in the forward direction (S_{21}) much lower than the power in the reverse direction (S_{12}).

Sweep Time

The **SWEEP TIME [ ],** softkey selects sweep time as the active entry and shows whether the automatic or manual mode is active. The following explains the difference between automatic and manual sweep time:

- Manual sweep time. As long as the selected sweep speed is within the capability of the instrument, it will remain fixed, regardless of changes to other measurement parameters. If you change measurement parameters such that the instrument can no longer maintain the selected sweep time, the analyzer will change to the fastest sweep time possible.
- Auto sweep time. Auto sweep time continuously maintains the fastest sweep speed possible with the selected measurement parameters.

Sweep time refers only to the time that the instrument is sweeping and taking data, and does not include the time required for internal processing of the data, retrace time, or band switching time. A sweep speed indicator ↑ is displayed on the trace for sweep times longer than 1.0 second. For sweep times equal to or faster than 1.0 second, the ↑ indicator appears in the status notations area at the left of the analyzer's display.

Manual Sweep Time Mode

When this mode is active, the softkey label reads **SWEEP TIME [MANUAL].** This mode is engaged whenever you enter a sweep time greater than zero. This mode allows you to select a fixed sweep time. If you change the measurement parameters such that the current sweep time is no longer possible, the analyzer will automatically increase to the next fastest sweep time possible. If the measurement parameters are changed such that a faster sweep time is possible, the analyzer will not alter the sweep time while in this mode.

Auto Sweep Time Mode

When this mode is active, the softkey label reads **SWEEP TIME [AUTO].** This mode is engaged whenever you enter **0, x1,** as a sweep time. Auto sweep time continuously maintains the fastest sweep time possible with the selected measurement parameters.

Minimum Sweep Time

The minimum sweep time is dependent on the following measurement parameters:

- the number of points selected
- IF bandwidth
- sweep-to-sweep averaging in dual channel display mode
- error-correction
- type of sweep

In addition to the these parameters, the actual cycle time of the analyzer is also dependent on the following measurement parameters:

- smoothing
- limit test
- trace math
- marker statistics

Refer to Chapter 1, "Specifications and Regulatory Information" to see the minimum cycle time values for specific measurement parameters.

Channel Stimulus Coupling

COUPLED CH on OFF, toggles the channel coupling of stimulus values. With **COUPLED CH ON,** (the preset condition), both channels have the same stimulus values. (The inactive channel takes on the stimulus values of the active channel.)

In the stimulus coupled mode, the following parameters are coupled:

- frequency
- number of points
- source power
- number of groups
- IF bandwidth
- sweep time
- trigger type
- sweep type
- power meter calibration

Coupling of stimulus values for the two channels is independent of **DUAL CHAN on OFF,** in the display menu and **MARKERS: UNCOUPLED,** in the marker mode menu. **COUPLED CH OFF,** activates an alternate sweep function when dual channel display is on. In this mode, the analyzer alternates between the two sets of stimulus values and displays the measurement data of both channels.

Sweep Types

The following sweep types will function with the interpolated error-correction feature:

- linear frequency
- power sweep
- CW time

The following sweep types will not function with the interpolated error correction feature:

- logarithmic frequency sweep
- list frequency sweep

Linear Frequency Sweep (Hz)

The **LIN FREQ** softkey activates a linear frequency sweep that is displayed on a standard graticule with ten equal horizontal divisions. This is the preset default sweep type.

For a linear sweep, sweep time is combined with the channel's frequency span to compute a source sweep rate:

sweep rate = (frequency span) / (sweep time)

Since the sweep time may be affected by various factors, the equation provided here is merely an indication of the ideal (fastest) sweep rate. If the user-specified sweep time is greater than 15 ms times the number of points, the sweep changes from a continuous ramp sweep to a stepped CW sweep. Also, for 10 Hz or 30 Hz IF bandwidths, the sweep is automatically converted to a stepped CW sweep.

Logarithmic Frequency Sweep (Hz)

The **LOG FREQ** softkey activates a logarithmic frequency sweep mode. The source is stepped in logarithmic increments and the data is displayed on a logarithmic graticule. This is slower than a continuous sweep with the same number of points, and the entered sweep time may therefore be changed automatically. For frequency spans of less than two octaves, the sweep type automatically reverts to linear sweep.

Stepped List Frequency Sweep (Hz)

The **LIST FREQ [STEPPED]** softkey activates a stepped list frequency sweep, one of two list frequency sweep modes. The stepped list mode allows the analyzer to sweep a list of arbitrary frequency points. This list is defined and modified using the edit list menu and the edit subsweep menu. Up to 30 frequency subsweeps (called "segments") of several different types can be specified, for a maximum total of 1601 points.

One list is common to both channels. Once a frequency list has been defined and a measurement calibration performed on the full frequency list, one or all of the frequency segments can be measured and displayed without loss of calibration.

When the **LIST FREQ [STEPPED],** key is pressed, the analyzer sorts all the defined frequency segments into CW points in order of increasing frequency. It then measures each point and displays a single trace that is a composite of all data taken. If duplicate frequencies exist, the analyzer makes multiple measurements on identical points to maintain the specified number of points for each subsweep. Since the frequency points may not be distributed evenly across the display, the display resolution may be uneven, and more compressed in some parts of the trace than in others. However, the stimulus and response readings of the markers are always accurate. Because the list frequency sweep is a stepped CW sweep, the sweep time is slower than for a continuous sweep with the same number of points.

Segment Menu

The **LIST FREQ [STEPPED],** softkey provides access to the segment menu, which allows you to select any single segment (**SINGLE SEG SWEEP,**) in the frequency list or all of the segments (**ALL SEGS SWEEP,**) in the frequency list. See the following information on how to enter or modify the list frequencies. If no list has been entered, the message `CAUTION: LIST TABLE EMPTY` is displayed. A tabular printout of the frequency list data can be obtained using the **LIST VALUES,** function in the copy menu.

Stepped Edit List Menu

The **EDIT LIST,** softkey within the sweep type menu provides access to the edit list menu.

This menu is used to edit the list of frequency segments (subsweeps) defined with the edit subsweep menu, described next. Up to 30 frequency subsweeps can be specified, for a maximum of 1601 points. The segments do not have to be entered in any particular order: the analyzer automatically sorts them and shows them on the display in increasing order of start frequency. This menu determines which entry on the list is to be modified, while the edit subsweep menu is used to make changes in the frequency or number of points of the selected entry.

Stepped Edit Subsweep Menu

Using the **EDIT,** or **ADD,** softkey within the edit list menu will display the edit subsweep menu. This menu lets you select measurement frequencies arbitrarily. Using this menu it is possible to define the exact frequencies to be measured on a point-by-point basis. For example, the sweep could include 100 points in a narrow passband, 100 points across a broad stop band, and 50 points across the third harmonic response. The total sweep is defined with a list of subsweeps.

The frequency subsweeps, or segments, can be defined in any of the following terms:

- start/stop/number of points
- start/stop/step
- center/span/number of points
- center/span/step
- CW frequency

The subsweeps can overlap, and do not have to be entered in any particular order. The analyzer sorts the segments automatically and lists them on the display in order of increasing start frequency, even if they are entered in center/span format. If duplicate frequencies exist, the analyzer makes multiple measurements on identical points to maintain the specified number of points for each subsweep. The data is shown on the display as a single trace that is a composite of all data taken. The trace may appear uneven because of the distribution of the data points, but the frequency scale is linear across the total range. Once the list frequencies have been defined or modified, the list frequency sweep mode can be selected with the **LIST FREQ [STEPPED],** softkey in the sweep type menu. The frequency list parameters can also be saved with an instrument state.

Swept List Frequency Sweep (Hz)

The **LIST FREQ [SWEPT]** softkey activates a swept list frequency sweep, one of two list frequency sweep modes. The swept list mode allows the analyzer to sweep a list of arbitrary frequency points which are defined and modified in a way similar to the stepped list mode. However, this mode takes data while *sweeping* through the defined frequency points, increasing throughput by up to 6 times over a stepped sweep. In addition, this mode allows the test port power and IF bandwidth to be set independently for each segment that is defined. The only restriction is that you cannot specify overlapping frequency segments.

Similar to stepped list mode, the **LIST FREQ [SWEPT]** softkey also provides access to the segment menu. However, swept list mode expands the way segments can be defined. Refer to the following information on how to enter or modify the list segments.

Swept Edit List Menu

The **EDIT LIST,** softkey within the sweep type menu provides access to the edit list menu. The function of this menu is the same as in the stepped list mode.

Swept Edit Subsweep Menu

Using the **EDIT,** or **ADD,** softkey within the edit list menu will display the edit subsweep menu. This menu lets you select measurement frequencies arbitrarily. Using this menu it is possible to define the exact frequencies to be measured on a point-by-point basis at specific power levels and IF bandwidth settings. The total sweep is defined with a list of subsweeps.

The frequency subsweeps, or segments, can be defined in any of the following terms:

- start/stop/number of points/power/IFBW
- start/stop/step/power/IFBW
- center/span/number of points/power/IFBW
- center/span/step/power/IFBW

  See "Setting Segment Power" and "Setting Segment IF Bandwidth" on page 5-9 for information on how to set the segment power and IF bandwidth.

The subsweeps may be entered in any particular order but they cannot overlap. The analyzer sorts the segments automatically and lists them on the display in order of increasing start frequency, even if they are entered in center/span format. The data is shown on the display as a single trace that is a composite of all data taken. The trace may appear uneven because of the distribution of the data points, but the frequency scale is linear across the total range.

Once the list frequencies have been defined or modified, the list frequency sweep mode can be selected with the **LIST FREQ [SWEPT],** softkey in the sweep type menu. The frequency list parameters can also be saved with an instrument state.

Setting Segment Power

To enable the **SEGMENT POWER,** function, you must first select **LIST POWER ON off,** in the edit subsweep menu. List power is off by default and the asterisks that appear in the "power" column of the list table indicate that power for the sweep is being set by the normal analyzer power controls.

The power settings for all segments are restricted to a single power range. This prevents the attenuator from switching to different settings mid-sweep. Select the power range and then edit the list table to specify the segment powers. If the power range is selected after the list has been defined, the list settings may be affected.

When analyzer port power is uncoupled, the segment power level can be set independently for each port. To do this, you must first select a measurement parameter to activate the port whose power you want to set. For example, select S11 to set port 1 power, or S22 to set port 2 power. (Notice that the list mode table will only display the currently selected port in the table. This is due to restricted display space.)

When analyzer port power is uncoupled, the **LIST POWER ON off,** softkey can also be set independently for each port. For example, you may choose to set **LIST POWER ON off,** for forward measurements and **LIST POWER on OFF,** for reverse measurements. In this case, the power would be set according to values in the list when measuring the forward parameters. When measuring the reverse parameters, the power would be set according to the normal analyzer power controls.

Setting Segment IF Bandwidth

To enable the **SEGMENT IF BW,** function, you must first select **LIST IF BW ON off,** in the edit subsweep menu. List IF bandwidth is off by default and the asterisks that appear in the "IFBW" column of the list table indicate that the IF bandwidth for the sweep is being set by the normal analyzer controls.

Narrow IF bandwidths require more data samples per point and thus slow down the measurement time. Selectable IF bandwidths can increase the throughput of the measurement by allowing you to specify narrow bandwidths only where needed.

Power Sweep (dBm)

The **POWER SWEEP,** softkey turns on a power sweep mode that is used to characterize power-sensitive circuits. In this mode, power is swept at a single frequency, from a start power value to a stop power value, selected using the **Start,** and **Stop,** keys and the entry block. This feature is convenient for such measurements as gain compression or AGC (automatic gain control) slope. To set the frequency of the power sweep, use **CW FREQ,** in the stimulus menu.

The span of the swept power is limited to being equal to or within one of the eight pre-defined power ranges. The attenuator will not switch to a different power range while in the power sweep mode. Therefore, when performing a power sweep, power range selection will automatically switch to the *manual* mode.

In power sweep, the entered sweep time may be automatically changed if it is less than the minimum required for the current configuration (number of points, IF bandwidth, averaging, etc.).

CW Time Sweep (Seconds)

The **CW TIME,** softkey turns on a sweep mode similar to an oscilloscope. The analyzer is set to a single frequency, and the data is displayed versus time. The frequency of the CW time sweep is set with **CW FREQ,** in the stimulus menu. In this sweep mode, the data is continuously sampled at precise, uniform time intervals determined by the sweep time and the number of points minus 1. The entered sweep time may be automatically changed if it is less than the minimum required for the current instrument configuration.

S-Parameters

The **Meas,** key accesses the S-parameter (Electrical Parameters) menu which contains softkeys that can be used to select the parameters or inputs that define the type of measurement being performed.

Understanding S-Parameters

S-parameters (scattering parameters) are a convention used to characterize the way a device modifies signal flow. A brief explanation of the S-parameters of a two-port device is provided, however, for additional details, refer to Application Notes 95-1 and 154.

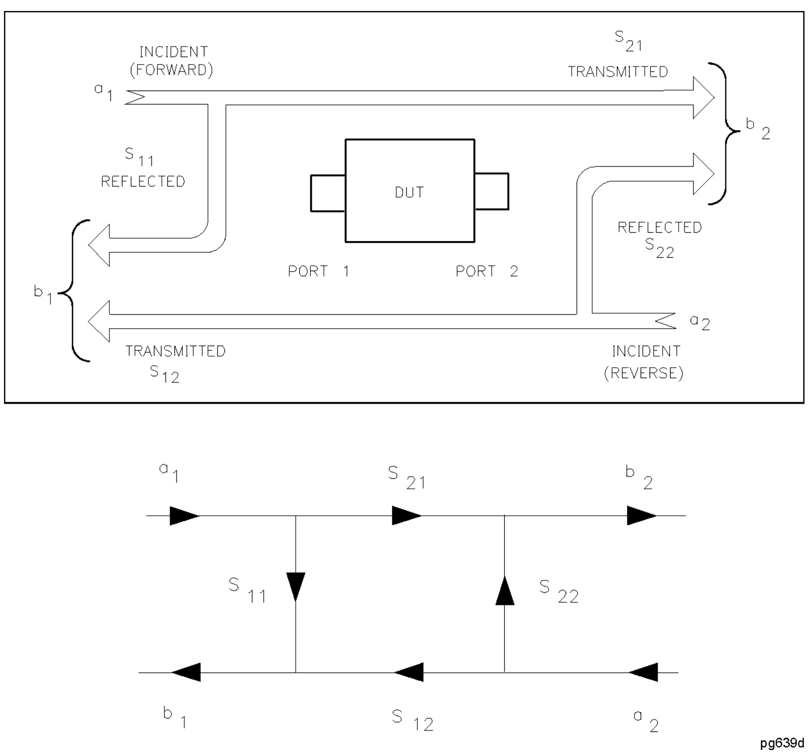
S-parameters are always a ratio of two complex (magnitude and phase) quantities. S-parameter notation identifies these quantities using the numbering convention:

S out in

where the first number (out) refers to the test-device port where the signal is emerging and the second number (in) is the test-device port where the signal is incident. For example, the S-parameter S_{21} identifies the measurement as the complex ratio of the signal emerging at the test device's port 2 to the signal incident at the test device's port 1.

Figure 5-2 on page 5-11 is a representation of the S-parameters of a two-port device, together with an equivalent flowgraph. In the illustration, "a" represents the signal entering the device and "b" represents the signal emerging. Note that a and b are not related to the A and B input ports on the analyzer.

Figure 5-2. S-Parameters of a Two-Port Device



S-parameters are exactly equivalent to these more common description terms, requiring only that the measurements be taken with all test device ports properly terminated.

S-Parameter	Definition		Test Set Description	Direction
S_{11}	b_1/a_1	$a_2 = 0$	Input reflection coefficient	FWD
S_{21}	b_2/a_1	$a_2 = 0$	Forward gain	FWD
S_{12}	b_1/a_2	$a_1 = 0$	Reverse Gain	REV
S_{22}	b_2/a_2	$a_1 = 0$	Output reflection coefficient	REV

The Electrical Parameters Menu

The Electrical Parameters menu allows you to define the input ports and test set direction for S-parameter measurements. The analyzer automatically switches the direction of the measurement according to the selections you made in this menu. Therefore, the analyzer can measure all four S-parameters with a single connection. The S-parameter being measured is labeled at the top left corner of the display.

The Electrical Parameters menu contains the following softkeys:

- **Refl: FWD S11 (A/R),**
- **Trans: FWD S21 (B/R),**
- **Trans: REV S12 (A/R),**
- **Refl: REV S22 (B/R),**
- **ANALOG IN Aux Input,**
- **CONVERSION [ ],** accesses the conversion menu.
- **INPUT PORTS,** accesses the input ports menu.

Analog In Menu

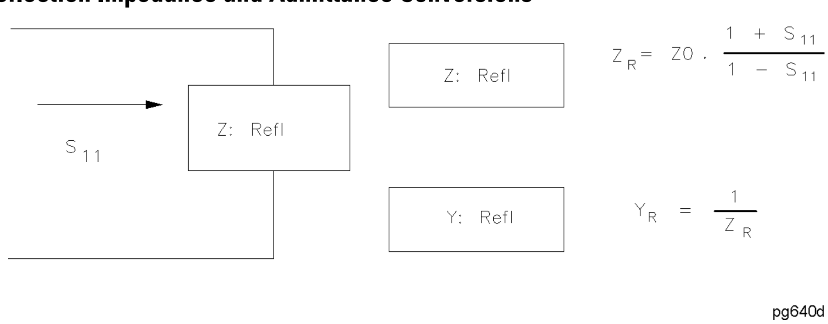
This menu allows you to monitor voltage and frequency nodes, using the analog bus and internal counter.

Conversion Menu

This menu converts the measured reflection or transmission data to the equivalent complex impedance (Z) or admittance (Y) values. This is not the same as a two-port Y or Z parameter conversion, as only the measured parameter is used in the equations. Two simple one-port conversions are available, depending on the measurement configuration.

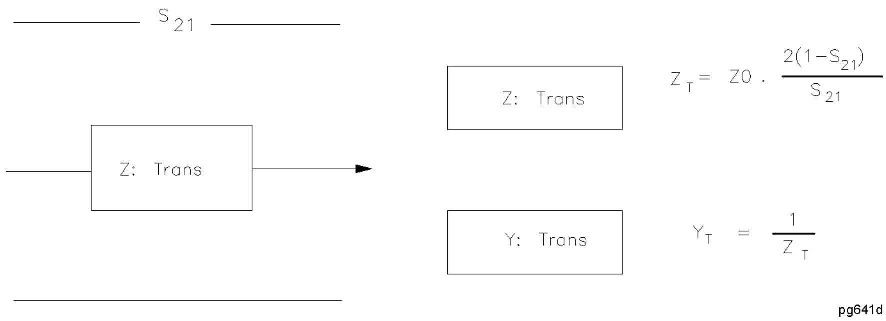
An S_{11} or S_{22} trace measured as reflection can be converted to equivalent parallel impedance or admittance using the model and equations shown in Figure 5-3.

Figure 5-3. Reflection Impedance and Admittance Conversions



In a transmission measurement, the data can be converted to its equivalent series impedance or admittance using the model and equations shown in Figure 5-4 on page 5-13.

Figure 5-4. Transmission Impedance and Admittance Conversions



NOTE Avoid the use of Smith chart, SWR, and delay formats for display of Z and Y conversions, as these formats are not easily interpreted.

Input Ports Menu

This menu allows you to define the input ports for power ratio measurements, or a single input for magnitude only measurements of absolute power. You cannot use single inputs for phase or group delay measurements, or any measurements with averaging activated.

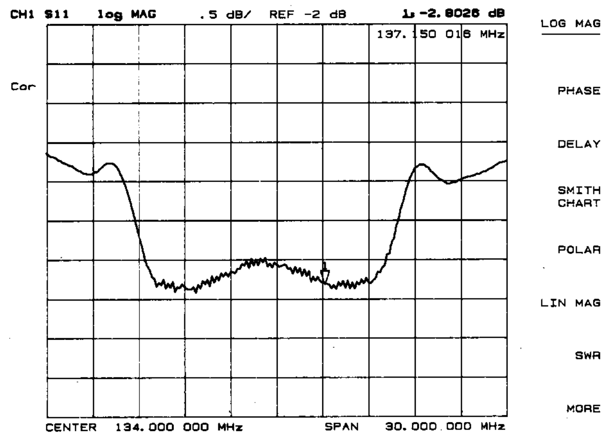
Analyzer Display Formats

The **Format,** key accesses the format menu. This menu allows you to select the appropriate display format for the measured data. The analyzer automatically changes the units of measurement to correspond with the displayed format. Special marker menus are available for the polar and Smith formats, each providing several different marker types for readout of values. The selected display format of a particular S-parameter or input is assigned to that parameter. Thus if different S-parameters are measured, even if only one channel is used, each parameter is shown in its selected format each time it is displayed. The following illustrations show a reflection measurement of a bandpass filter displayed in each of the available formats.

Log Magnitude Format

The **LOG MAG,** softkey displays the log magnitude format. This is the standard Cartesian format used to display magnitude-only measurements of insertion loss, return loss, or absolute power in dB versus frequency. The bandpass filter reflection data in a log magnitude format is illustrated in Figure 5-5.

Figure 5-5. Log Magnitude Format

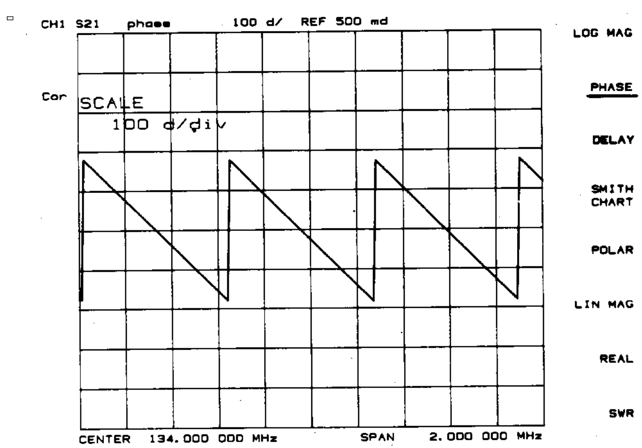


pg6184_c

Phase Format

The **PHASE,** softkey displays a Cartesian format of the phase portion of the data, measured in degrees. This format displays the phase shift versus frequency. The phase response of the same filter in a phase-only format is illustrated in Figure 5-6 on page 5-14.

Figure 5-6. Phase Format

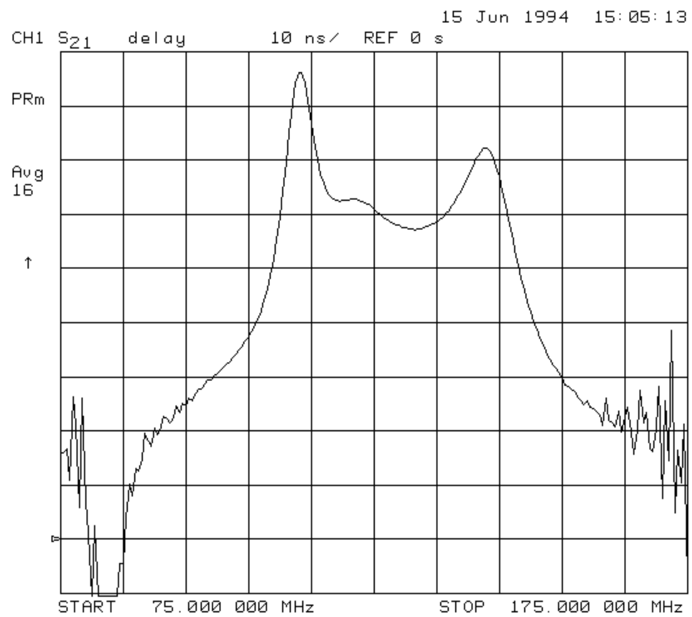


pg6178_c

Group Delay Format

The **DELAY,** softkey selects the group delay format, with marker values given in seconds. The bandpass filter response formatted as group delay is shown in Figure 5-7. Group delay principles are described in the next few pages.

Figure 5-7. Group Delay Format



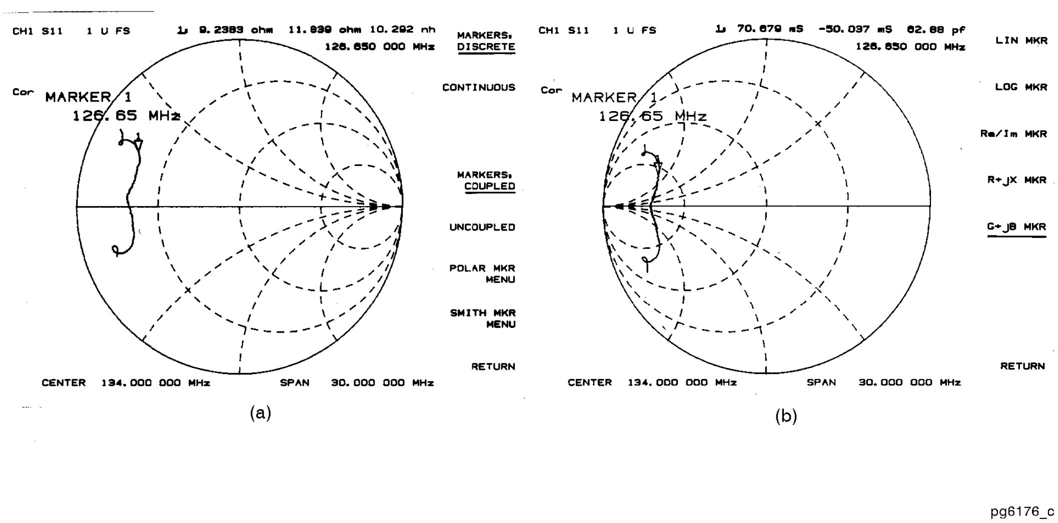
Smith Chart Format

The **SMITH CHART,** softkey displays a Smith chart format. Refer to Figure 5-8. This is used in reflection measurements to provide a readout of the data in terms of impedance. The intersecting dotted lines on the Smith chart represent constant resistance and constant reactance values, normalized to the characteristic impedance, Z_0, of the system. Reactance values in the upper half of the Smith chart circle are positive (inductive) reactance, and those in the lower half of the circle are negative (capacitive) reactance. The default marker readout is in ohms (Ω) to measure resistance and reactance (R+jX). Additional marker types are available in the Smith marker menu.

The Smith chart is most easily understood with a full scale value of 1.0. If the scale per division is less than 0.2, the format switches automatically to polar. If the characteristic impedance of the system is not 50 ohms, modify the impedance value recognized by the analyzer by pressing **Cal, MORE, SET Z0,** (the impedance value) **x1.**

An inverted Smith chart format for admittance measurements is also available. This is shown in Figure 5-8. Access this by selecting **SMITH CHART,** in the format menu, and pressing **Marker Fctn, MKR MODE MENU, SMITH MKR MENU, G+jB MKR.** The Smith chart is inverted and marker values are read out in siemens (S) to measure conductance and susceptance (G+jB).

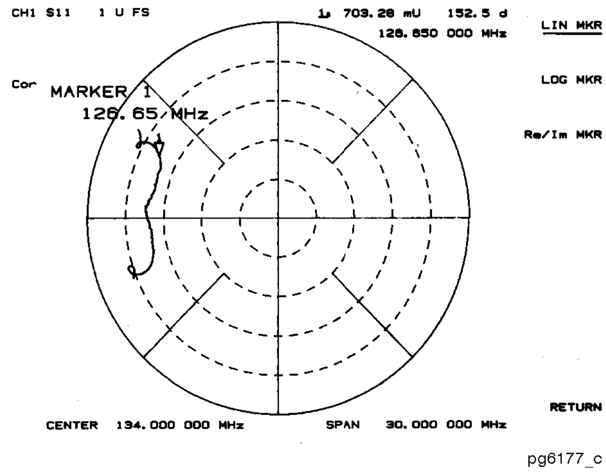
Figure 5-8. Standard and Inverse Smith Chart Formats



Polar Format

The **POLAR,** softkey displays a polar format as shown in Figure 5-9 on page 5-17. Each point on the polar format corresponds to a particular value of both magnitude and phase. Quantities are read vectorally: the magnitude at any point is determined by its displacement from the center (which has zero value), and the phase by the angle counterclockwise from the positive x-axis. Magnitude is scaled in a linear fashion, with the value of the outer circle usually set to a ratio value of 1. Since there is no frequency axis, frequency information is read from the markers. The default marker readout for the polar format is in linear magnitude and phase. A log magnitude marker and a real/imaginary marker are available in the polar marker menu.

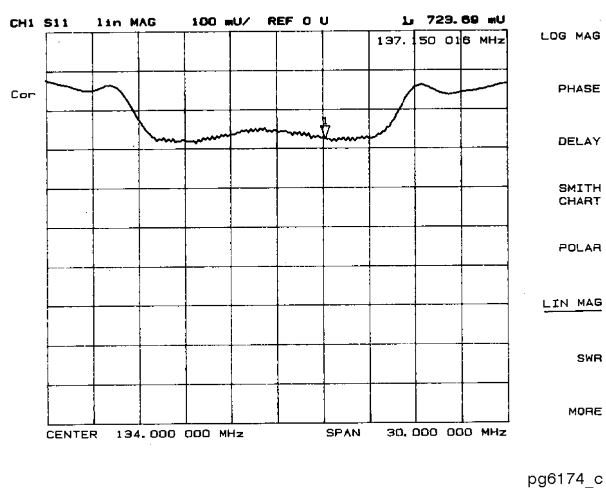
Figure 5-9. Polar Format



Linear Magnitude Format

The **LIN MAG,** softkey displays the linear magnitude format as shown in Figure 5-10. This is a Cartesian format used for unitless measurements such as reflection coefficient magnitude ρ or transmission coefficient magnitude τ, and for linear measurement units. It is used for display of conversion parameters and time domain transform data.

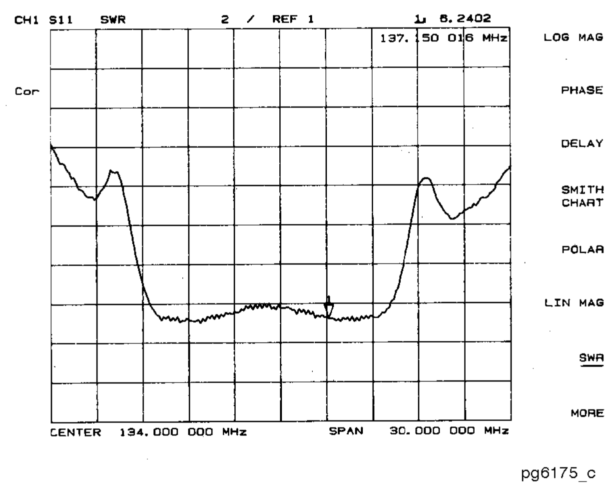
Figure 5-10. Linear Magnitude Format



SWR Format

The **SWR,** softkey reformats a reflection measurement into its equivalent SWR (standing wave ratio) value. See Figure 5-11. SWR is equivalent to (1 + ρ)/(1 – ρ), where ρ is the reflection coefficient. Note that the results are valid only for reflection measurements. If the SWR format is used for measurements of S_{21} or S_{12} the results are not valid.

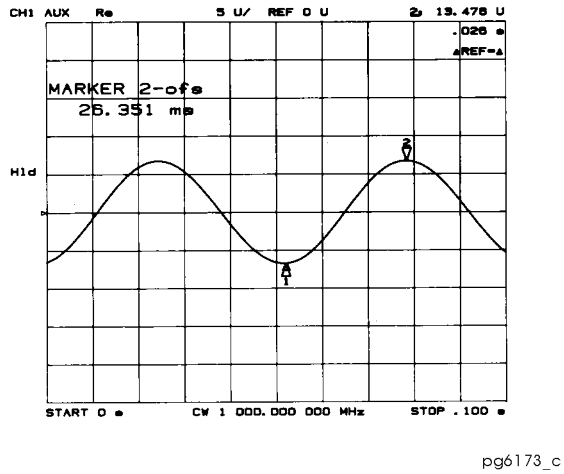
Figure 5-11. Typical SWR Display



Real Format

The **REAL,** softkey displays only the real (resistive) portion of the measured data on a Cartesian format. See Figure 5-12. This is similar to the linear magnitude format, but can show both positive and negative values.

Figure 5-12. Real Format



Imaginary Format

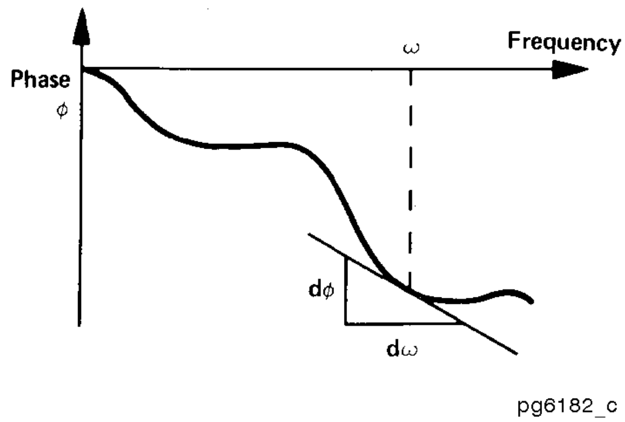
The **IMAGINARY,** softkey displays only the imaginary (reactive) portion of the measured data on a Cartesian format. This format is similar to the real format except that reactance data is displayed on the trace instead of resistive data.

Group Delay Principles

For many networks, the amount of insertion phase is not as important as the linearity of the phase shift over a range of frequencies. The analyzer can measure this linearity and express it in two different ways: directly, as deviation from linear phase, or as group delay, a derived value.

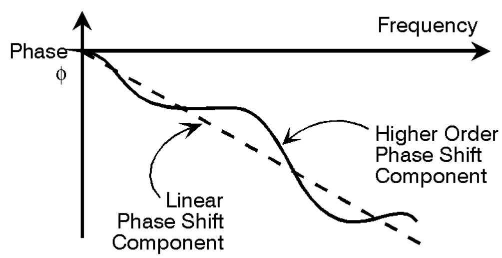
Group delay is the measurement of signal transmission time through a test device. It is defined as the derivative of the phase characteristic with respect to frequency. Since the derivative is basically the instantaneous slope (or rate of change of phase with respect to frequency), a perfectly linear phase shift results in a constant slope, and therefore a constant group delay. See Figure 5-13.

Figure 5-13. Constant Group Delay



Note, however, that the phase characteristic typically consists of both linear and higher order (deviations from linear) components. The linear component can be attributed to the electrical length of the test device, and represents the average signal transit time. The higher order components are interpreted as variations in transit time for different frequencies, and represent a source of signal distortion. See Figure 5-14 on page 5-20.

Figure 5-14. Higher Order Phase Shift



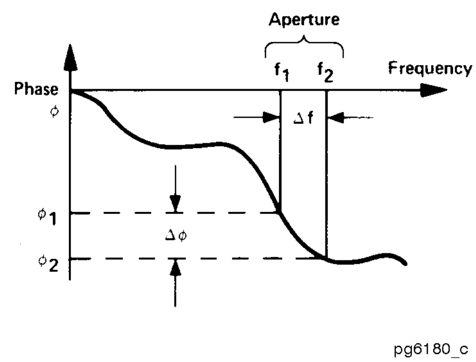
$$\text{Group Delay} = \tau_g = \frac{-d\,\phi}{d\,\omega} \qquad \begin{array}{l}\phi \text{ in Radians} \\ \omega \text{ in Radians/Sec}\end{array}$$

$$= \frac{-1}{360°} \cdot \frac{d\,\phi}{df} \qquad \begin{array}{l}\phi \text{ in Degrees} \\ f \text{ in Hz } (\omega = 2\pi f)\end{array}$$

pb6115d

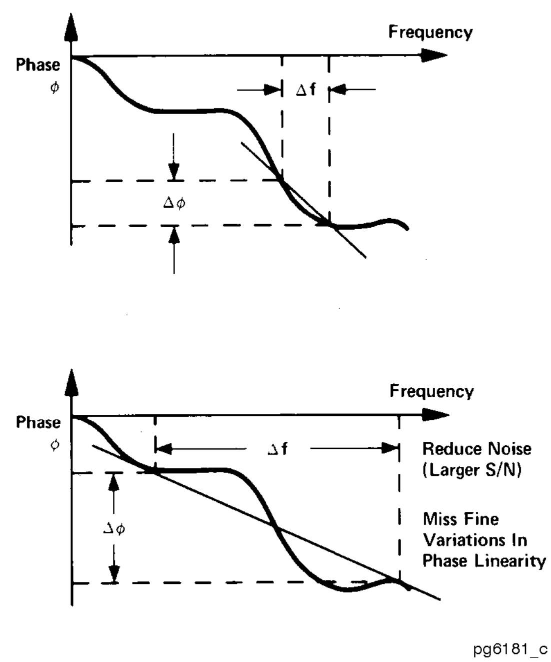
The analyzer computes group delay from the phase slope. Phase data is used to find the phase change, $\Delta\Phi$ over a specified frequency aperture, Δf, to obtain an approximation for the rate of change of phase with frequency. Refer to Figure 5-15. This value, $(\tau)_g$, represents the group delay in seconds assuming linear phase change over Δf. It is important that $\Delta\Phi$ be $\leq 180°$, or errors will result in the group delay data. These errors can be significant for long delay devices. You can verify that $\Delta\Phi$ is $\leq 180°$ by increasing the number of points or narrowing the frequency span (or both) until the group delay data no longer changes.

Figure 5-15. Rate of Phase Change Versus Frequency



When deviations from linear phase are present, changing the frequency step can result in different values for group delay. Note that in this case the computed slope varies as the aperture Δf is increased. See Figure 5-16 on page 5-21. A wider aperture results in loss of the fine grain variations in group delay. This loss of detail is the reason that in any comparison of group delay data, it is important to know the aperture that was used to make the measurement.

Figure 5-16. Variations in Frequency Aperture



In determining the group delay aperture, there is a trade-off between resolution of fine detail and the effects of noise. Noise can be reduced by increasing the aperture, but this will tend to smooth out the fine detail. More detail will become visible as the aperture is decreased, but the noise will also increase, possibly to the point of obscuring the detail. A good practice is to use a smaller aperture to assure that small variations are not missed, then increase the aperture to smooth the trace.

The default group delay aperture is the frequency span divided by the number of points across the display. To set the aperture to a different value, turn on smoothing in the average menu, and vary the smoothing aperture. The aperture can be varied up to 20% of the span swept.

Group delay measurements can be made on linear frequency, log frequency, or list frequency sweep types (not in CW or power sweep). Group delay aperture varies depending on the frequency spacing and point density, therefore the aperture is not constant in log and list frequency sweep modes. In list frequency mode, extra frequency points can be defined to ensure the desired aperture.

To obtain a readout of aperture values at different points on the trace, turn on a marker. Then press **Avg, SMOOTHING APERTURE.** Smoothing aperture becomes the active function, and as the aperture is varied its value in Hz is displayed beneath the active entry area.

Electrical Delay

The **ELECTRICAL DELAY,** softkey adjusts the electrical delay to balance the phase of the test device. This softkey must be used in conjunction with **COAXIAL DELAY,** or **WAVEGUIDE DELAY,** (with cut-off frequency) in order to identify which type of transmission line the delay is being added to. These softkeys can be accessed by pressing the **Scale Ref,** key.

Electrical delay simulates a variable length lossless transmission line, which can be added to or removed from a receiver input to compensate for interconnecting cables, etc. This function is similar to the mechanical or analog "line stretchers" of network analyzers. Delay is annotated in units of time with secondary labeling in distance for the current velocity factor.

With this feature, and with **MARKER DELAY,** an equivalent length of air-filled, lossless transmission line is added or subtracted according to the following formula:

$$Length\ (meters) = \frac{\Phi}{(Freq\ (MHz) \times 1.20083)}$$

Once the linear portion of the test device's phase has been removed, the equivalent length of the lossless, transmission line can be read out in the active marker area. If the average relative permittivity (ε_r) of the test device is known over the frequency span, the length calculation can be adjusted to indicate the actual length of the test device more closely. This can be done by entering the relative velocity factor for the test device using the calibrate more menu. The relative velocity factor for a given dielectric can be calculated by:

$$Velocity\ Factor = \frac{1}{\sqrt{\varepsilon_r}}$$

assuming a relative permeability of 1.

Noise Reduction Techniques

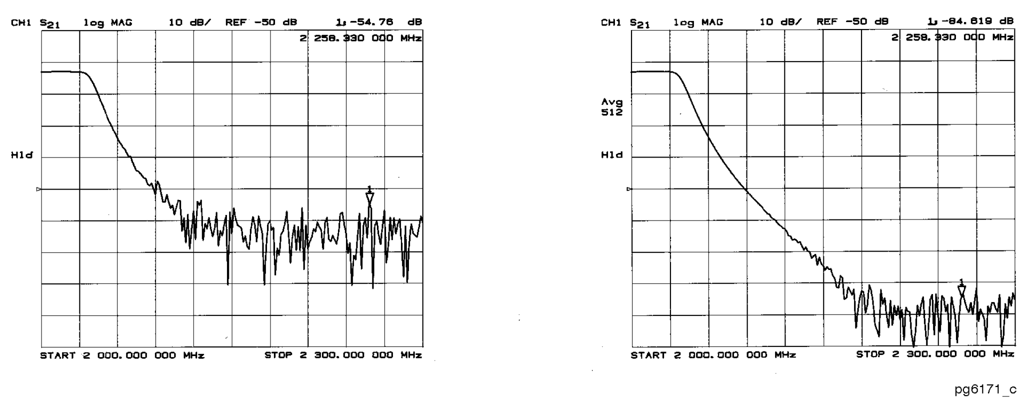
The **Avg,** key is used to access three different noise reduction techniques: sweep-to-sweep averaging, display smoothing, and variable IF bandwidth. All of these can be used simultaneously. Averaging and smoothing can be set independently for each channel, and the IF bandwidth can be set independently if the stimulus is uncoupled.

Averaging

Averaging computes each data point based on an exponential average of consecutive sweeps weighted by a user-specified averaging factor. Each new sweep is averaged into the trace until the total number of sweeps is equal to the averaging factor, for a fully averaged trace. Each point on the trace is the vector sum of the current trace data and the data from the previous sweep. A high averaging factor gives the best signal-to-noise ratio, but slows the trace update time. Doubling the averaging factor reduces the noise by 3 dB. Averaging is used for ratioed measurements: if it is attempted for a single-input measurement (e.g. A or B), the message `CAUTION: AVERAGING INVALID ON NON-RATIO MEASURE` is displayed. The effect of averaging on a log magnitude format trace is shown in Figure 5-17.

NOTE	If you switch power ranges with averaging on, the average will restart.

Figure 5-17. Effect of Averaging on a Trace



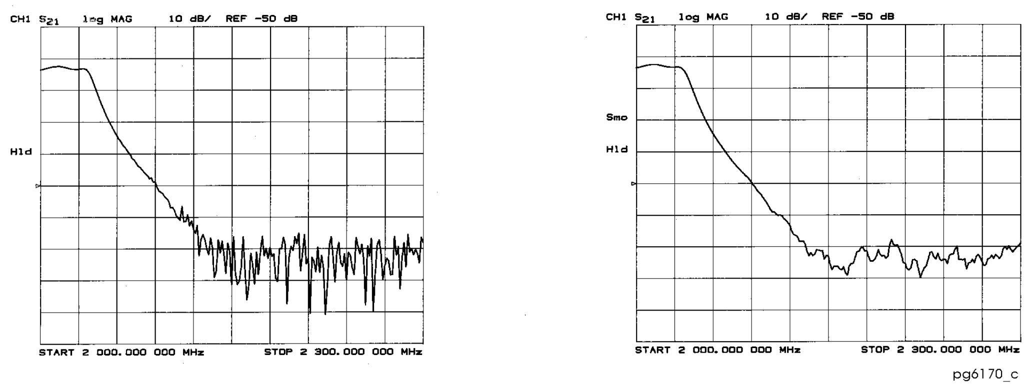
Smoothing

Smoothing (similar to video filtering) averages the formatted active channel data over a portion of the displayed trace. Smoothing computes each displayed data point based on one sweep only, using a moving average of several adjacent data points for the current sweep. The smoothing aperture is a percent of the swept stimulus span, up to a maximum of 20%.

Rather than lowering the noise floor, smoothing finds the mid-value of the data. Use it to reduce relatively small peak-to-peak noise values on broadband measured data. Use a sufficiently high number of display points to avoid misleading results. Do not use smoothing for measurements of high resonance devices or other devices with wide trace variations, as it will introduce errors into the measurement.

Smoothing is used with Cartesian and polar display formats. It is also the primary way to control the group delay aperture, given a fixed frequency span. Refer to “Group Delay Principles” on page 5-19. In polar display format, large phase shifts over the smoothing aperture will cause shifts in amplitude, since a vector average is being computed. The effect of smoothing on a log magnitude format trace is illustrated in Figure 5-18.

Figure 5-18. Effect of Smoothing on a Trace

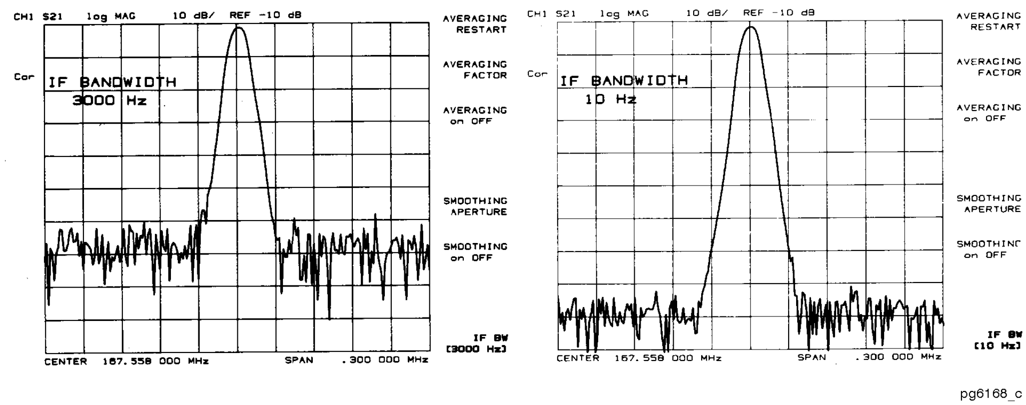


IF Bandwidth Reduction

IF bandwidth reduction lowers the noise floor by digitally reducing the receiver input bandwidth. It works in all ratio and non-ratio modes. It has an advantage over averaging as it reliably filters out unwanted responses such as spurs, odd harmonics, higher frequency spectral noise, and line-related noise. Sweep-to-sweep averaging, however, is better at filtering out very low frequency noise. A tenfold reduction in IF bandwidth lowers the measurement noise floor by about 10 dB. Bandwidths less than 300 Hz provide better harmonic rejection than higher bandwidths.

Another difference between sweep-to-sweep averaging and variable IF bandwidth is the sweep time. Averaging displays the first complete trace faster but takes several sweeps to reach a fully averaged trace. IF bandwidth reduction lowers the noise floor in one sweep, but the sweep time may be slower. The difference in noise floor between a trace measured with a 3000 Hz IF bandwidth and with a 10 Hz IF bandwidth is illustrated by Figure 5-19 on page 5-26.

Figure 5-19. IF Bandwidth Reduction



NOTE	Another capability that can be used for effective noise reduction is the marker statistics function, which computes the average value of part or all of the formatted trace.

Measurement Calibration

Measurement calibration is an accuracy enhancement procedure that effectively removes the system errors that cause uncertainty in measuring a test device. It measures known standard devices, and uses the results of these measurements to characterize the system.

This section discusses the following topics:

- definition of accuracy enhancement
- causes of measurement errors
- characterization of microwave systematic errors
- effectiveness of accuracy enhancement
- ensuring a valid calibration
- modifying calibration kits
- TRL*/LRM* calibration

What Is Accuracy Enhancement?

A perfect measurement system would have infinite dynamic range, isolation, and directivity characteristics, no impedance mismatches in any part of the test setup, and flat frequency response. In any high frequency measurement there are measurement errors associated with the system that contribute uncertainty to the results. Parts of the measurement setup such as interconnecting cables and signal-separation devices (as well as the analyzer itself) all introduce variations in magnitude and phase that can mask the actual performance of the test device. Vector accuracy enhancement, also known as measurement calibration or error-correction, provides the means to simulate a nearly perfect measurement system.

For example, crosstalk due to the channel isolation characteristics of the analyzer can contribute an error equal to the transmission signal of a high-loss test device. For reflection measurements, the primary limitation of dynamic range is the directivity of the test setup. The measurement system cannot distinguish the true value of the signal reflected by the test device from the signal arriving at the receiver input due to leakage in the system. For both transmission and reflection measurements, impedance mismatches within the test setup cause measurement uncertainties that appear as ripples superimposed on the measured data.

Error-correction simulates an improved analyzer system. During the measurement calibration process, the analyzer measures the magnitude and phase responses of known standard devices, and compares the measurement with actual device data. The analyzer uses the results to characterize the system and effectively remove the system errors from the measurement data of a test device, using vector math capabilities internal to the network analyzer. When you use a measurement calibration, the dynamic range and accuracy of the measurement are limited only by system noise and stability, connector repeatability, and the accuracy to which the characteristics of the calibration standards are known.

What Causes Measurement Errors?

Network analysis measurement errors can be separated into systematic, random, and drift errors.

Correctable systematic errors are the repeatable errors that the system can measure. These are errors due to mismatch and leakage in the test setup, isolation between the reference and test signal paths, and system frequency response. The system cannot measure and correct for the non-repeatable random and drift errors. These errors affect both reflection and transmission measurements. Random errors are measurement variations due to noise and connector repeatability. Drift errors include frequency drift, temperature drift, and other physical changes in the test setup between calibration and measurement.

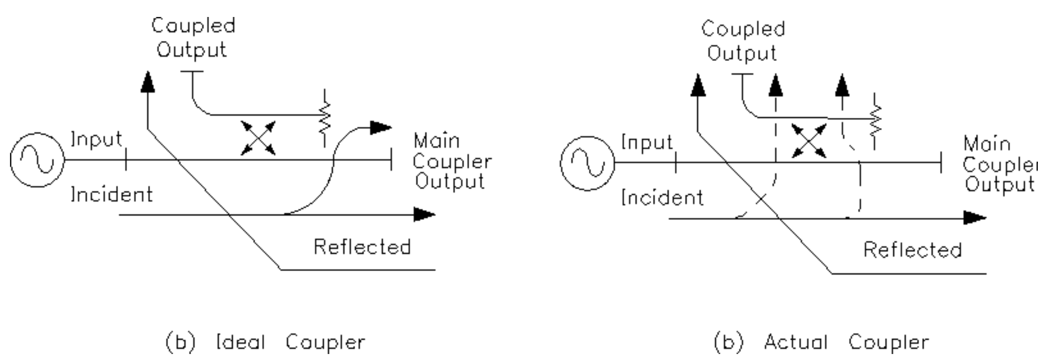
The resulting measurement is the vector sum of the test device response plus all error terms. The precise effect of each error term depends upon its magnitude and phase relationship to the actual test device response.

In most high frequency measurements the systematic errors are the most significant source of measurement uncertainty. Since each of these errors can be characterized, their effects can be effectively removed to obtain a corrected value for the test device response. For the purpose of vector accuracy enhancement, these uncertainties are quantified as directivity, source match, load match, isolation (crosstalk), and frequency response (tracking). The description of each of these systematic errors follows. Random and drift errors cannot be precisely quantified, so they must be treated as producing a cumulative uncertainty in the measured data.

Directivity

Normally a device that can separate the reverse from the forward traveling waves (a directional bridge or coupler) is used to detect the signal reflected from the test device. Ideally the coupler would completely separate the incident and reflected signals, and only the reflected signal would appear at the coupled output, as shown in Figure 5-20a.

Figure 5-20. Directivity



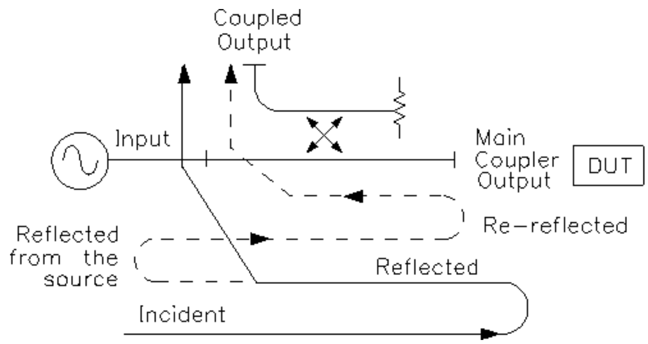
However, an actual coupler is not perfect, as shown in Figure 5-20b. A small amount of the incident signal appears at the coupled output due to leakage as well as reflection from the termination in the coupled arm. Also, reflections from the coupler output connector appear at the coupled output, adding uncertainty to the signal reflected from the device. The figure of merit for how well a coupler separates forward and reverse waves is directivity. The greater the directivity of the device, the better the signal separation. System directivity is the vector sum of all leakage signals appearing at the analyzer receiver input. The error contributed by directivity is independent of the characteristics of the test device and it usually produces the major ambiguity in measurements of low reflection devices.

Source Match

Source match is defined as the vector sum of signals appearing at the analyzer receiver input due to the impedance mismatch at the test device looking back into the source, as well as to adapter and cable mismatches and losses. In a reflection measurement, the source match error signal is caused by some of the reflected signal from the test device being reflected from the source back toward the test device and re-reflected from the test device. This is illustrated in Figure 5-21. In a transmission measurement, the source match error signal is caused by reflection from the test device that is re-reflected from the source.

Source match is most often given in terms of return loss in dB: thus the larger the number, the smaller the error.

Figure 5-21. Source Match

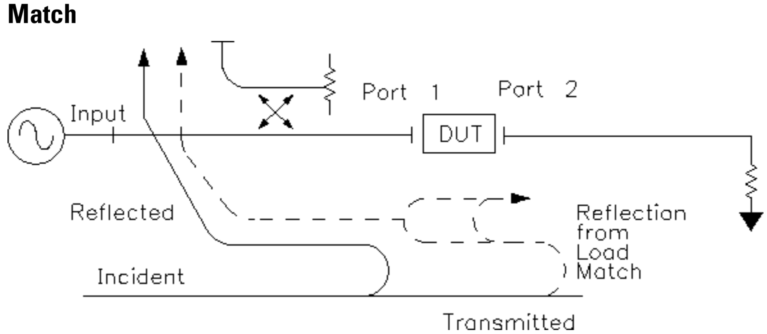


The error contributed by source match is dependent on the relationship between the actual input impedance of the test device and the equivalent match of the source. It is a factor in both transmission and reflection measurements. Source match is a particular problem in measurements where there is a large impedance mismatch at the measurement plane. (For example, reflection devices such as filters with stop bands.)

Load Match

Load match error results from an imperfect match at the output of the test device. It is caused by impedance mismatches between the test device output port and port 2 of the measurement system. Some of the transmitted signal is reflected from port 2 back to the test device as illustrated in Figure 5-22. A portion of this wave may be re-reflected to port 2, or part may be transmitted through the device in the reverse direction to appear at port 1. If the test device has low insertion loss (for example a filter pass band), the signal reflected from port 2 and re-reflected from the source causes a significant error because the test device does not attenuate the signal significantly on each reflection. Load match is usually given in terms of return loss in dB: thus the larger the number, the smaller the error.

Figure 5-22. Load Match



The error contributed by load match is dependent on the relationship between the actual output impedance of the test device and the effective match of the return port (port 2). It is a factor in all transmission measurements and in reflection measurements of two-port devices. The interaction between load match and source match is less significant when the test device insertion loss is greater than about 6 dB. However, source match and load match still interact with the input and output matches of the DUT, which contributes to transmission measurement errors. (These errors are largest for devices with highly reflective ports.)

Isolation (Crosstalk)

Leakage of energy between analyzer signal paths contributes to error in a transmission measurement, much like directivity does in a reflection measurement. Isolation is the vector sum of signals appearing at the analyzer samplers due to crosstalk between the reference and test signal paths. This includes signal leakage within the test set and in both the RF and IF sections of the receiver.

The error contributed by isolation depends on the characteristics of the test device. Isolation is a factor in high-loss transmission measurements. However, analyzer system isolation is more than sufficient for most measurements, and correction for it may be unnecessary.

For measuring devices with high dynamic range, accuracy enhancement can provide improvements in isolation that are limited only by the noise floor. Generally, the isolation falls below the noise floor, therefore, when performing an isolation calibration you should use a noise reduction function such as averaging or reduce the IF bandwidth.

Frequency Response (Tracking)

This is the vector sum of all test setup variations in which magnitude and phase change as a function of frequency. This includes variations contributed by signal-separation devices, test cables, adapters, and variations between the reference and test signal paths. This error is a factor in both transmission and reflection measurements.

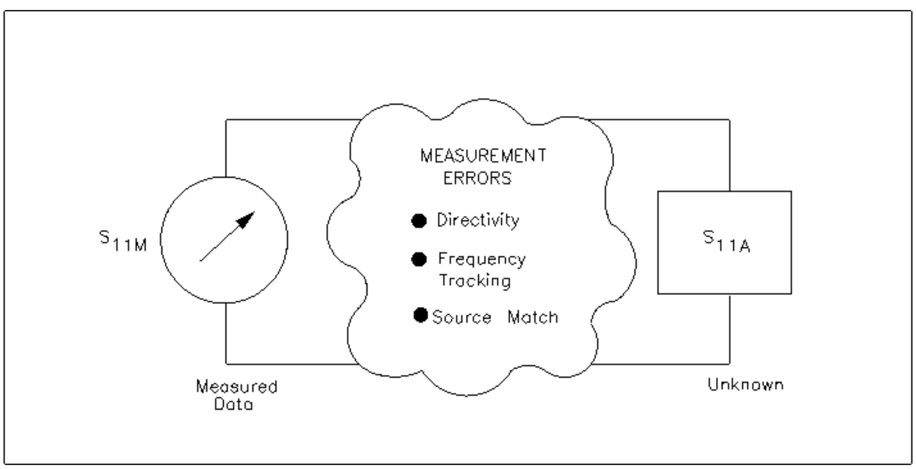
For further explanation of systematic error terms and the way they are combined and represented graphically in error models, refer to the “Characterizing Microwave Systematic Errors” in the following section.

Characterizing Microwave Systematic Errors

One-Port Error Model

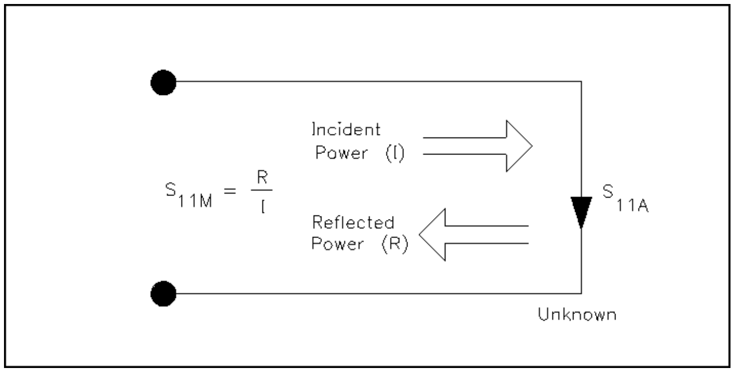
In a measurement of the reflection coefficient (magnitude and phase) of a test device, the measured data differs from the actual, no matter how carefully the measurement is made. Directivity, source match, and reflection signal path frequency response (tracking) are the major sources of error. See Figure 5-23 on page 5-30.

Figure 5-23. Sources of Error in a Reflection Measurement



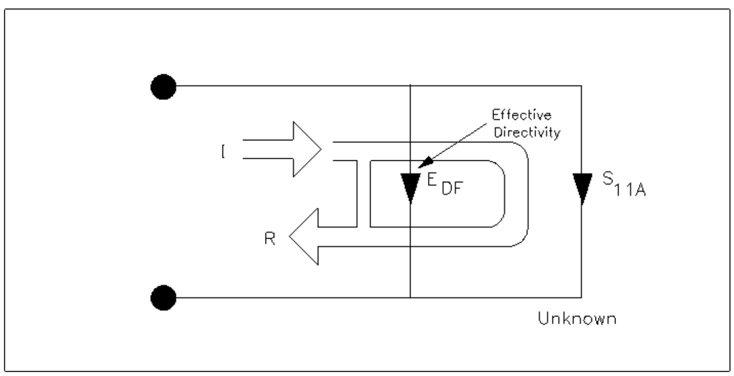
To characterize the errors, the reflection coefficient is measured by first separating the incident signal (I) from the reflected signal (R), then taking the ratio of the two values. See Figure 5-24. Ideally, (R) consists only of the signal reflected by the test device (S_{11A}, for S_{11} actual).

Figure 5-24. Reflection Coefficient



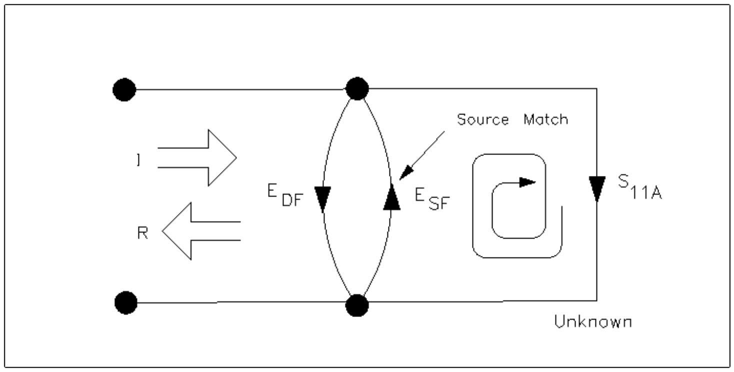
However, all of the incident signal does not always reach the unknown. Refer to Figure 5-25 on page 5-31. Some of (I) may appear at the measurement system input due to leakage through the test set or through a signal separation device. Also, some of (I) may be reflected by imperfect adapters between a signal separation device and the measurement plane. The vector sum of the leakage and the miscellaneous reflections is the effective directivity, E_{DF}. Understandably, the measurement is distorted when the directivity signal combines vectorally with the actual reflected signal from the unknown, S_{11A}.

Figure 5-25. Effective Directivity E_{DF}



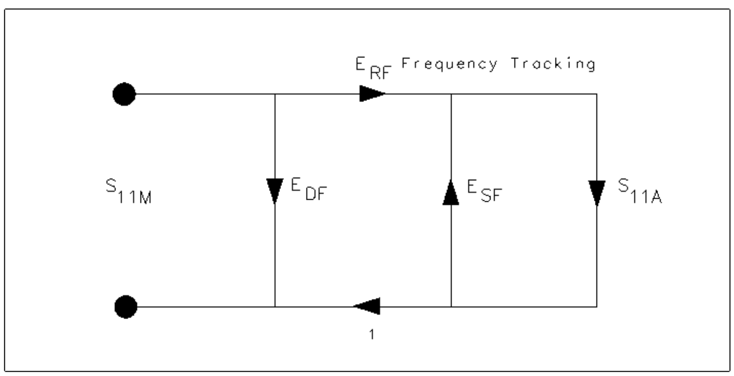
Since the measurement system test port is never exactly the characteristic impedance (50 ohms), some of the reflected signal bounces off the test port, or other impedance transitions further down the line, and back to the unknown, adding to the original incident signal (I). This effect causes the magnitude and phase of the incident signal to vary as a function of S_{11A} and frequency. Leveling the source to produce a constant incident signal (I) reduces this error, but since the source cannot be exactly leveled at the test device input, leveling cannot eliminate all power variations. This re-reflection effect and the resultant incident power variation are caused by the source match error, E_{SF} as shown in Figure 5-26.

Figure 5-26. Source Match E_{SF}



Frequency response (tracking) error is caused by variations in magnitude and phase flatness versus frequency between the test and reference signal paths. These are due mainly to coupler roll off, imperfectly matched samplers, and differences in length and loss between the incident and test signal paths. The vector sum of these variations is the reflection signal path tracking error, E_{RF} as shown in Figure 5-27 on page 5-32.

Figure 5-27. Reflection Tracking E_{RF}

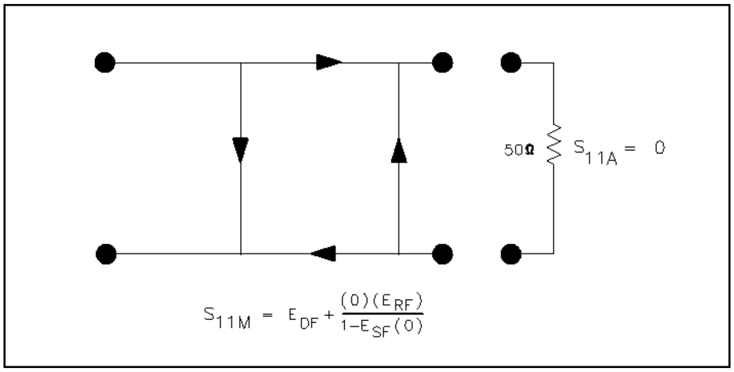


These three errors are mathematically related to the actual data, S_{11A}, and measured data, S_{11M}, by the following equation:

$$S_{11M} = E_{DF} + \frac{(S_{11A}\ E_{RF})}{(1 - E_{SF}\ S_{11A})}$$

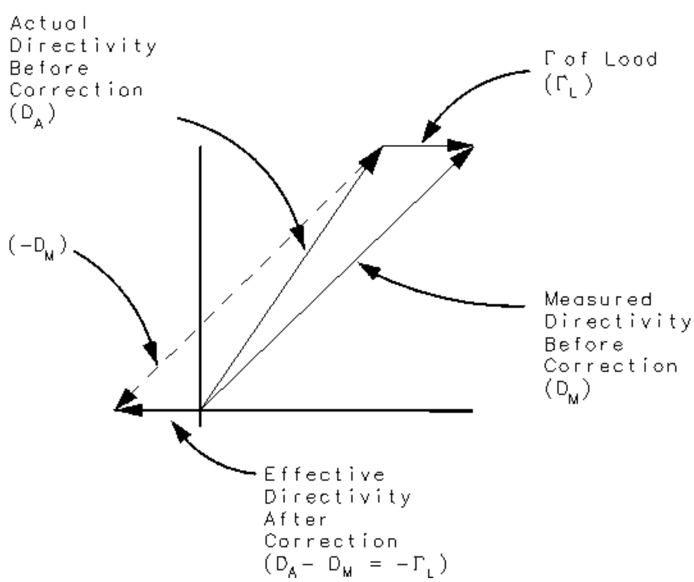
If the value of these three "E" errors and the measured test device response were known for each frequency, this equation could be solved for S_{11A} to obtain the actual test device response. Because each of these errors changes with frequency, their values must be known at each test frequency. These values are found by measuring the system at the measurement plane using three independent standards whose S_{11A} is known at all frequencies. The first standard applied is a "perfect load," which makes $S_{11A} = 0$ and essentially measures directivity. See Figure 5-28 on page 5-33. "Perfect load" implies a reflectionless termination at the measurement plane. All incident energy is absorbed. With $S_{11A} = 0$ the equation can be solved for E_{DF}, the directivity term. In practice, of course, the "perfect load" is difficult to achieve, although very good broadband loads are available in the compatible calibration kits.

Figure 5-28. "Perfect Load" Termination



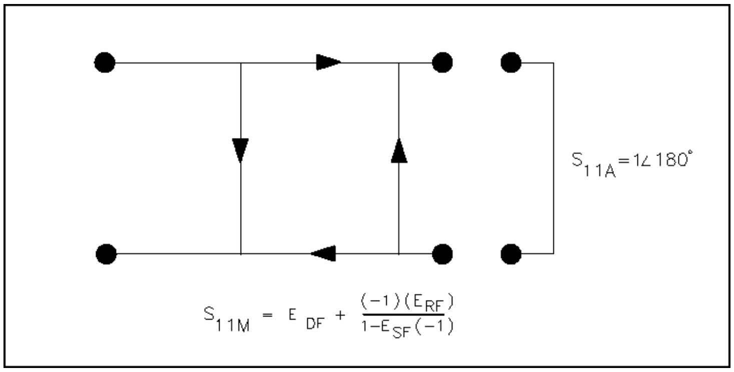
Since the measured value for directivity is the vector sum of the actual directivity plus the actual reflection coefficient of the "perfect load," any reflection from the termination represents an error. System effective directivity becomes the actual reflection coefficient of the near "perfect load" as shown in Figure 5-29. In general, any termination having a return loss value greater than the uncorrected system directivity reduces reflection measurement uncertainty.

Figure 5-29. Measured Effective Directivity



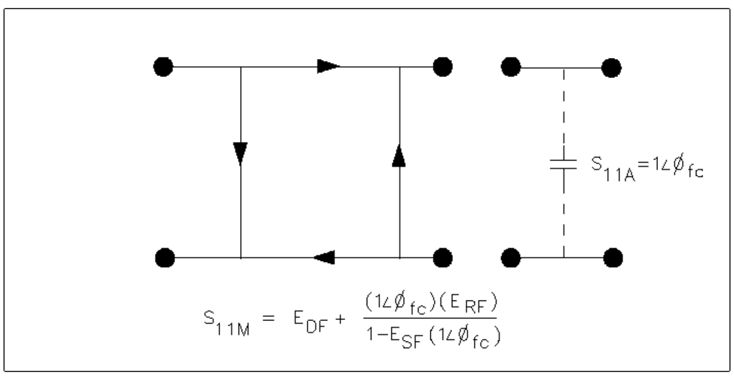
Next, a short circuit termination whose response is known to a very high degree is used to establish another condition as shown in Figure 5-30 on page 5-34.

Figure 5-30. Short Circuit Termination



The open circuit gives the third independent condition. In order to accurately model the phase variation with frequency due to fringing capacitance from the open connector, a specially designed shielded open circuit is used for this step. (The open circuit capacitance is different with each connector type.) Now the values for E_{DF}, directivity, E_{SF}, source match, and E_{RF}, reflection frequency response, are computed and stored. See Figure 5-31.

Figure 5-31. Open Circuit Termination

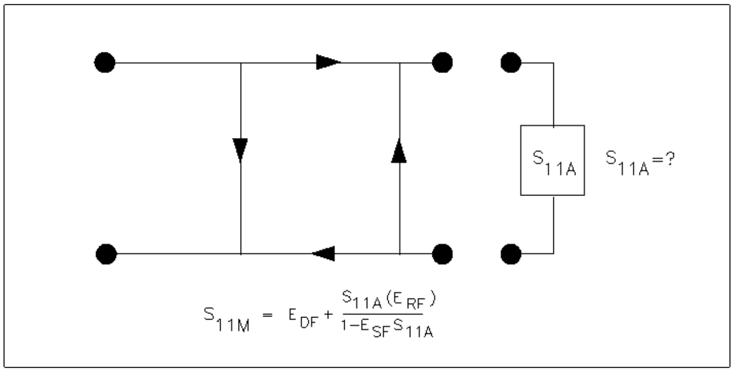


This completes the calibration procedure for one port devices.

Device Measurement

Now the unknown is measured to obtain a value for the measured response, S_{11M}, at each frequency. Refer to Figure 5-32 on page 5-35.

Figure 5-32. Measured S_{11}



This is the one-port error model equation solved for S_{11A}. Since the three errors and S_{11M} are now known for each test frequency, S_{11A} can be computed as follows:

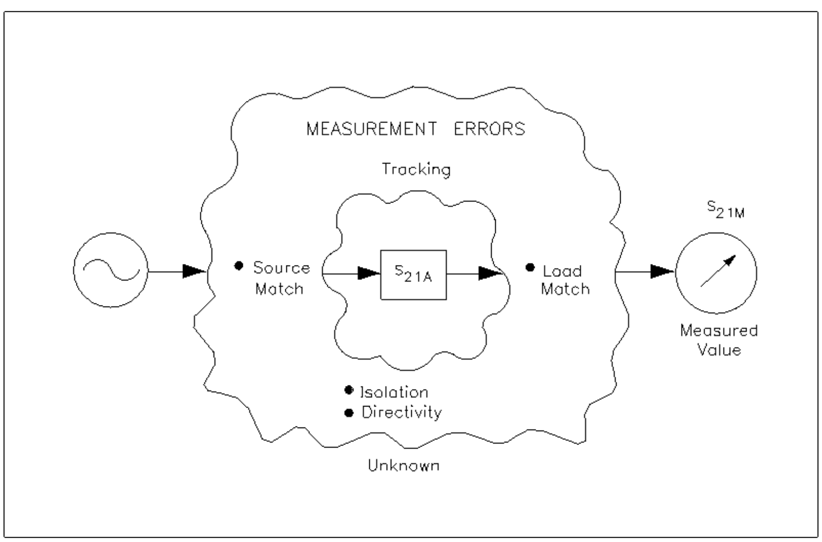
$$S_{11A} = \frac{(S_{11M} - E_{DF})}{E_{SF}\ (S_{11M} - E_{DF})\ + E_{RF}}$$

For reflection measurements on two-port devices, the same technique can be applied, but the test device output port must be terminated in the system characteristic impedance. This termination should have as low a reflection coefficient as the load used to determine directivity. The additional reflection error caused by an improper termination at the test device's output port is not incorporated into the one-port error model.

Two-Port Error Model

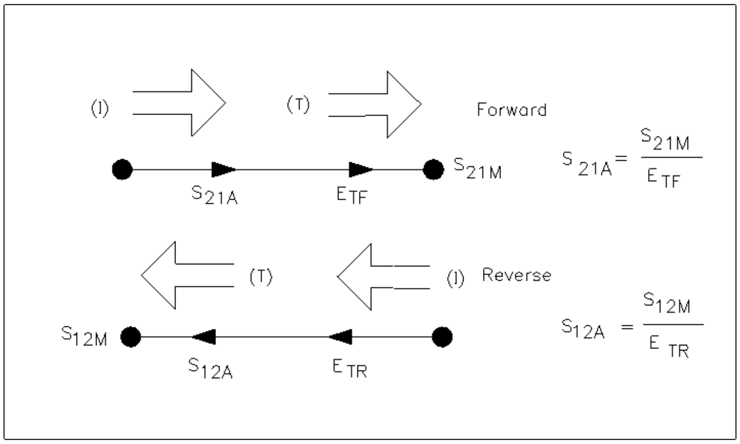
The error model for measurement of the transmission coefficients (magnitude and phase) of a two-port device is derived in a similar manner. The potential sources of error are frequency response (tracking), source match, load match, and isolation as shown in Figure 5-33 on page 5-35. These errors are effectively removed using the full two-port error model.

Figure 5-33. Major Sources of Error



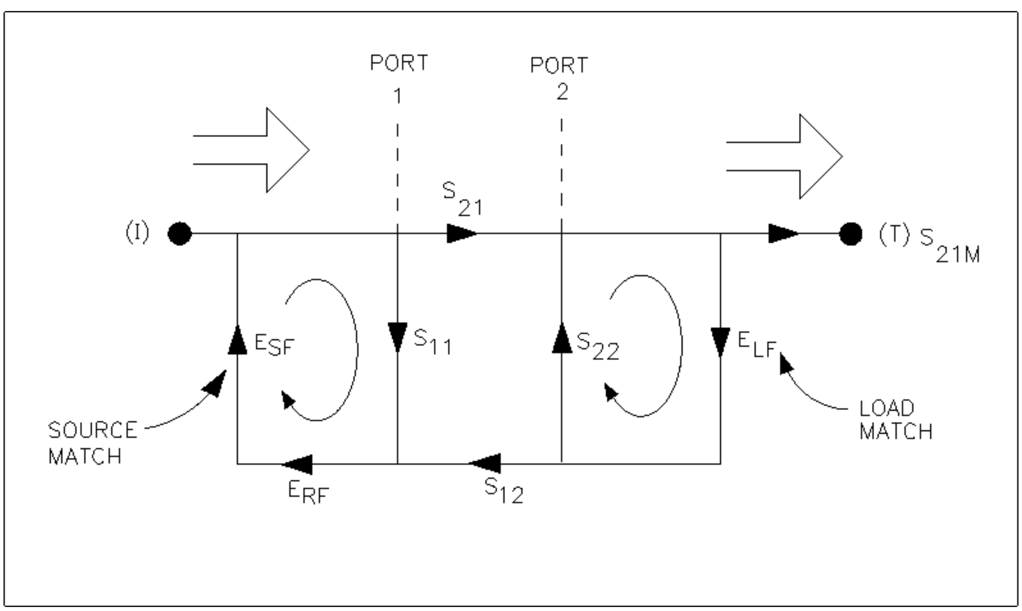
The transmission coefficient is measured by taking the ratio of the incident signal (I) and the transmitted signal (T). Refer to Figure 5-34. Ideally, (I) consists only of power delivered by the source, and (T) consists only of power emerging at the test device output.

Figure 5-34. Transmission Coefficient



As in the reflection model, source match can cause the incident signal to vary as a function of test device S_{11A}. Also, since the test setup transmission return port is never exactly the characteristic impedance, some of the transmitted signal is reflected from the test set port 2, and from other mismatches between the test device output and the receiver input, to return to the test device. A portion of this signal may be re-reflected at port 2, thus affecting S_{21M}, or part may be transmitted through the device in the reverse direction to appear at port 1, thus affecting S_{11M}. This error term, which causes the magnitude and phase of the transmitted signal to vary as a function of S_{22A}, is called load match, E_{LF}. See Figure 5-35 on page 5-36.

Figure 5-35. Load Match E_{LF}



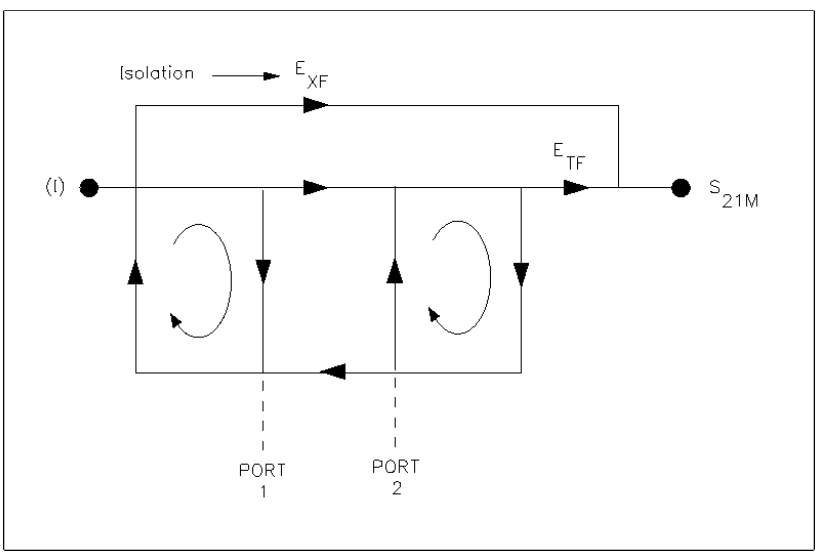
The measured value, S_{21M}, consists of signal components that vary as a function of the relationship between E_{SF} and S_{11A} as well as E_{LF} and S_{22A}, so the input and output reflection coefficients of the test device must be measured and stored for use in the S_{21A} error-correction computation. Thus, the test setup is calibrated as described for reflection to establish the directivity, E_{DF}, source match, E_{SF}, and reflection frequency response, E_{RF}, terms for reflection measurements on both ports.

Now that a calibrated port is available for reflection measurements, the thru is connected and load match, E_{LF}, is determined by measuring the reflection coefficient of the thru connection. Transmission signal path frequency response is then measured with the thru connected. The data is corrected for source and load match effects, then stored as transmission frequency response, E_{TF}.

NOTE It is very important that the exact electrical length of the thru be known. Most calibration kits assume a zero length thru. For some connection types such as Type-N, this implies one male and one female port. If the test system requires a non-zero length thru, for example, one with two male test ports, the exact electrical delay of the thru adapter must be used to modify the built-in calibration kit definition of the thru.

Isolation, E_{XF}, represents the part of the incident signal that appears at the receiver without actually passing through the test device. See Figure 5-36 on page 5-37. Isolation is measured with the test set in the transmission configuration and with terminations installed at the points where the test device will be connected. Since isolation can be lower than the noise floor, it is best to increase averaging by at least a factor of four during the isolation portion of the calibration. The **RESUME CAL SEQUENCE,** softkey under the **Cal,** menu allows a calibration sequence to resume after a change to the averaging factor. If the leakage falls below the noise floor, it is best to increase averaging before calibration. In this case, omitting isolation is better than measuring the isolation standards without increasing the averaging factor.

Figure 5-36. Isolation E_{XF}



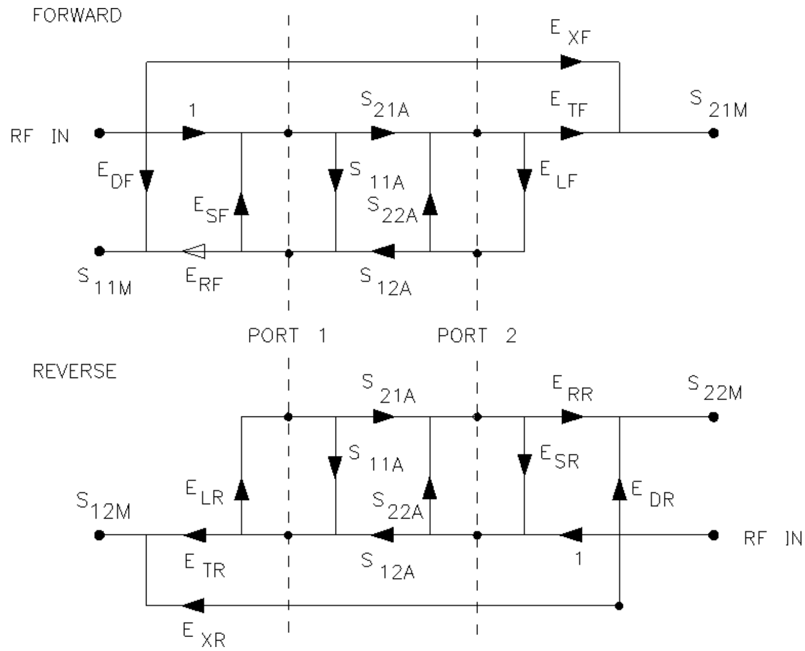
Thus there are two sets of error terms, forward and reverse, with each set consisting of six error terms, as follows:

- Directivity, E_{DF} (forward) and E_{DR} (reverse)
- Isolation, E_{XF} and E_{XR}
- Source Match, E_{SF} and E_{SR}
- Load Match, E_{LF} and E_{LR}

- Transmission Tracking, E_{TF} and E_{TR}
- Reflection Tracking, E_{RF} and E_{RR}

The analyzer's test set can measure both the forward and reverse characteristics of the test device without you having to manually remove and physically reverse the device. A full two-port error model illustrated in Figure 5-37 on page 5-38. This illustration depicts how the analyzer effectively removes both the forward and reverse error terms for transmission and reflection measurements.

Figure 5-37. Full Two-Port Error Model



A full two-port error model equations for all four S-parameters of a two-port device is shown in Figure 5-38 on page 5-39. Note that the mathematics for this comprehensive model use all forward and reverse error terms and measured values. Thus, to perform full error-correction for any one parameter, all four S-parameters must be measured. Applications of these error models are provided in the calibration procedures described in the user's guide.

Enhanced Response Calibration Error Model Enhanced response calibration uses the same error model as the forward configuration portion of Figure 5-37. In the response portion, the source and load match effects are fully-accounted for giving the same accuracy to the forward tracking term (E_{TF}) as the two-port calibration. During the measurement, the enhanced response calibration performs a correction which is mathematically the same as setting the values of E_{LF}, E_{LR}, E_{SR}, E_{XR}, E_{DR} to zero (0) and the values of E_{RR} and E_{TR} to one (1) in the equations for S11 and S21 shown in Figure 5-38 on page 5-39.

Figure 5-38. Full Two-Port Error Model Equations

$$S_{11A} = \frac{\left[\left(\frac{S_{11M} - E_{DF}}{E_{RF}}\right)\left[1 + \left(\frac{S_{22M} - E_{DR}}{E_{RR}}\right)E_{SR}\right]\right] - \left[\left(\frac{S_{21M} - E_{XF}}{E_{TF}}\right)\left(\frac{S_{12M} - E_{XR}}{E_{TR}}\right)E_{LF}\right]}{\left[1 + \left(\frac{S_{11M} - E_{DF}}{E_{RF}}\right)E_{SF}\right]\left[1 + \left(\frac{S_{22M} - E_{DR}}{E_{RR}}\right)E_{SR}\right] - \left[\left(\frac{S_{21M} - E_{XF}}{E_{TF}}\right)\left(\frac{S_{12M} - E_{XR}}{E_{TR}}\right)E_{LF}E_{LR}\right]}$$

$$S_{21A} = \frac{\left[1 + \left(\frac{S_{22M} - E_{DR}}{E_{RR}}\right)\left(E_{SR} - E_{LF}\right)\right]\left(\frac{S_{21M} - E_{XF}}{E_{TF}}\right)}{\left[1 + \left(\frac{S_{11M} - E_{DF}}{E_{RF}}\right)E_{SF}\right]\left[1 + \left(\frac{S_{22M} - E_{DR}}{E_{RR}}\right)E_{SR}\right] - \left[\left(\frac{S_{21M} - E_{XF}}{E_{TF}}\right)\left(\frac{S_{12M} - E_{XR}}{E_{TR}}\right)E_{LF}E_{LR}\right]}$$

$$S_{12A} = \frac{\left[1 + \left(\frac{S_{11M} - E_{DF}}{E_{RF}}\right)\left(E_{SF} - E_{LR}\right)\right]\left(\frac{S_{12M} - E_{XR}}{E_{TR}}\right)}{\left[1 + \left(\frac{S_{11M} - E_{DF}}{E_{RF}}\right)E_{SF}\right]\left[1 + \left(\frac{S_{22M} - E_{DR}}{E_{RR}}\right)E_{SR}\right] - \left[\left(\frac{S_{21M} - E_{XF}}{E_{TF}}\right)\left(\frac{S_{12M} - E_{XR}}{E_{TR}}\right)E_{LF}E_{LR}\right]}$$

$$S_{22A} = \frac{\left[\left(\frac{S_{22M} - E_{DR}}{E_{RR}}\right)\left[1 + \left(\frac{S_{11M} - E_{DF}}{E_{RF}}\right)E_{SF}\right]\right] - \left[\left(\frac{S_{21M} - E_{XF}}{E_{TF}}\right)\left(\frac{S_{12M} - E_{XR}}{E_{TR}}\right)E_{LR}\right]}{\left[1 + \left(\frac{S_{11M} - E_{DF}}{E_{RF}}\right)E_{SF}\right]\left[1 + \left(\frac{S_{22M} - E_{DR}}{E_{RR}}\right)E_{SR}\right] - \left[\left(\frac{S_{21M} - E_{XF}}{E_{TF}}\right)\left(\frac{S_{12M} - E_{XR}}{E_{TR}}\right)E_{LF}E_{LR}\right]}$$

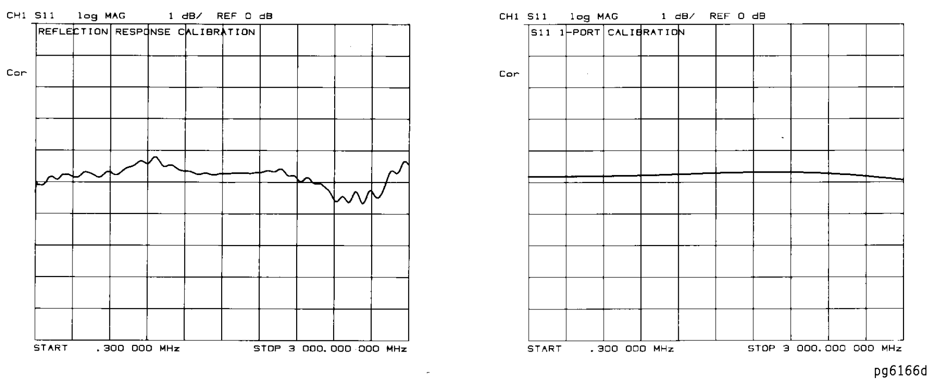
How Effective Is Accuracy Enhancement?

In addition to the errors removed by accuracy enhancement, other systematic errors exist due to limitations of dynamic accuracy, test set switch repeatability, and test cable stability. These, combined with random errors, also contribute to total system measurement uncertainty. Therefore, after accuracy enhancement procedures are performed, residual measurement uncertainties remain.

The uncorrected performance of the analyzer is sufficient for many measurements. However, the next three illustrations show the improvements that can be made in measurement accuracy by using a more complete calibration routine. See Figure 5-39, and Figure 5-40 on page 5-40, and Figure 5-41 on page 5-41.

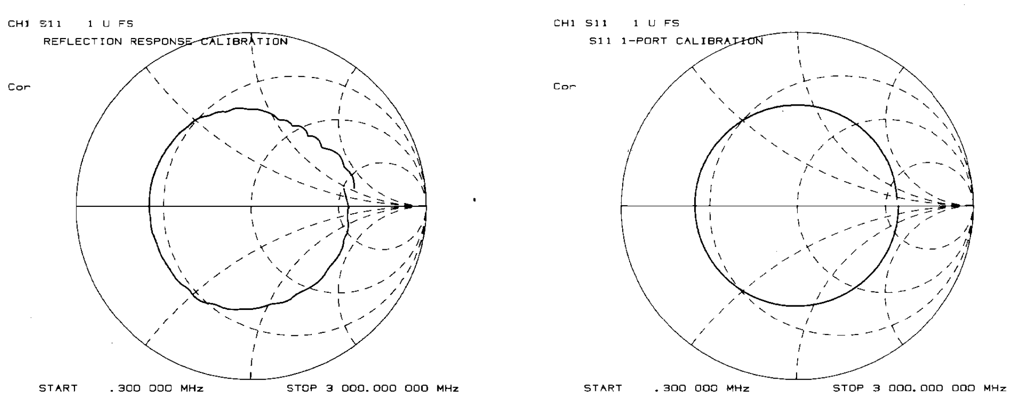
Figure 5-39a shows a measurement in log magnitude format with a response calibration only. Figure 5-39b shows the improvement in the same measurement using an S11 one-port calibration. Figure 5-40a shows the measurement on a Smith chart with response calibration only, and Figure 5-40b shows the same measurement with an S11 one-port calibration.

Figure 5-39. Response versus S11 1-Port Calibration on Log Magnitude Format



(a) *(b)*

Figure 5-40. Response versus S_{11} 1-Port Calibration on Smith Chart

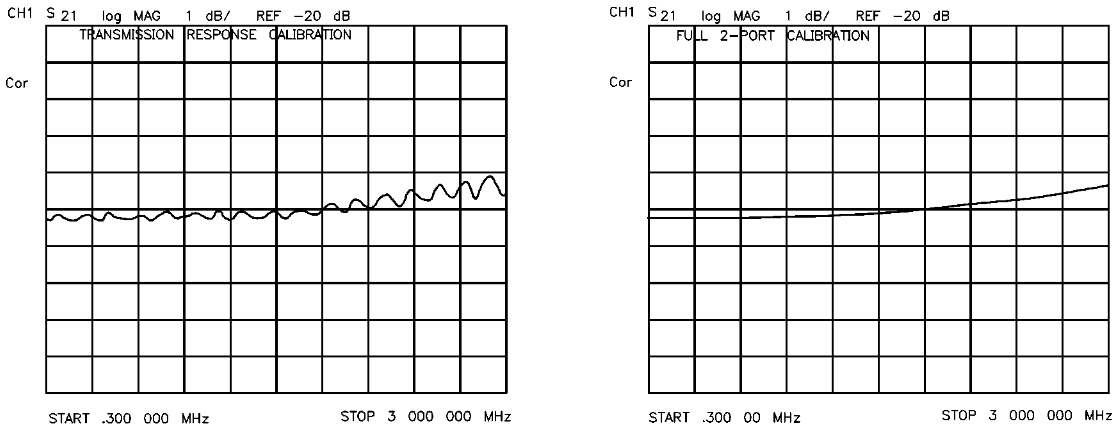


(a) *(b)*

pg6167_c

The response of a device in a log magnitude format is shown in Figure 5-41 on page 5-41. Figure 5-41a shows the response using a response calibration and Figure 5-41b the response using a full two-port calibration.

Figure 5-41. Response versus Full Two-Port Calibration



Calibration Routines

There are twelve different error terms for a two-port measurement that can be corrected by accuracy enhancement in the analyzer. These are directivity, source match, load match, isolation, reflection tracking, and transmission tracking, each in both the forward and reverse direction. The analyzer has several different measurement calibration routines to characterize one or more of the systematic error terms and remove their effects from the measured data.

The calibrate menu allows you to perform the measurement calibration routines. These procedures range from a simple frequency response calibration to a full two-port calibration that effectively removes all twelve error terms.

Response Calibration for All Device Types

The response calibration provides a normalization of the test setup for reflection or transmission measurements. This calibration procedure may be adequate for measurement of well matched devices. This is the simplest error-correction to perform, and should be used when extreme measurement accuracy is not required. You can access this calibration by pressing the **RESPONSE** softkey within the calibrate menu

Response and Isolation Calibration for All Device Types

The response and isolation calibration provides a normalization for frequency response and crosstalk errors in transmission measurements, or frequency response and directivity errors in reflection measurements. This procedure may be adequate for measurement of well matched high-loss devices. You can access this calibration by pressing the **RESPONSE & ISOL'N** softkey within the calibrate menu.

Response and Match for O/E and E/O Devices

The response and match calibration removes the frequency response errors and electrical port match errors. The port match errors occur because of reflections between: 1) The electrical output port of the analyzer and the input port of an E/O device, and 2) The output port of an O/E device and the electrical input port of the analyzer. You can access this calibration by pressing the **RESPONSE & MATCH** softkey within the calibrate menu.

Optical Calibration Kit Modifications

Characteristics of the optical calibration standard models in the analyzer can be modified to more closely match the actual standards in use.

Definitions

- Fresnel Reflection: The reflection of a portion of incident light at a planar interface between two homogenous media having different refractive indexes.

  For calibration standards, this term is used to refer to an optical fiber-air interface. The most common type of Fresnel reflection used for calibration is that formed by an unterminated connector. Theoretically, the amount of power reflected at this interface is 3.5%. That is, 3.5% of the optical power is reflected back to the source and 96.5% is transmitted from the cable into air.

- Reflector: A device that causes the abrupt reversal of direction of a light beam. Reflection from a smooth surface is termed specular, while reflection from a rough surface is termed diffuse.

The theoretical power reflected is 100%. However, this factor can be adjusted from 0% to 100% to account for any practical reflector being used in the calibration.

Electrical Calibration Kit Modifications

Modifying electrical calibration kits is necessary only if unusual standards (such as in TRL*) are used or the very highest accuracy is required. Unless a calibration kit model is provided with the calibration devices used, a solid understanding of error-correction and the system error model are absolutely essential to making modifications. You may use modifications to a predefined calibration kit by modifying the kit and saving it as a user kit. The original predefined calibration kit will remain unchanged.

Before attempting to modify calibration standard definitions, you should read Application Note 8510-5A to improve your understanding of modifying calibration kits. The part number of this application note is 5956-4352. Although the application note is written for the 8510 family of network analyzers, it also applies to this network analyzer.

Several situations exist that may require a user-defined calibration kit:

- A calibration is required for a connector interface different from the four default calibration kits. (Examples: SMA, TNC, or waveguide.)
- A calibration with standards (or combinations of standards) that are different from the default calibration kits is required. (Example: Using three offset shorts instead of open, short, and load to perform a 1-port calibration.)
- The built-in standard models for default calibration kits can be improved or refined. Remember that the more closely the model describes the actual performance of the standard, the better the calibration. (Example: The 7 mm load is determined to be 50.4 Ω instead of 50.0 Ω.)

Definitions

The following are definitions of terms:

- A "standard" (represented by a number 1-8) is a specific, well-defined, physical device used to determine systematic errors. For example, standard 1 is a short in the 3.5 mm calibration kit. Standards are assigned to the instrument softkeys as part of a class.
- A standard "type" is one of five basic types that define the form or structure of the model to be used with that standard (short, open, load, delay/thru, and arbitrary impedance); standard 1 is of the type short in the 3.5 mm calibration kit.
- Standard "coefficients" are numerical characteristics of the standards used in the model selected. For example, the offset delay of the short is 32 ps in the 3.5 mm calibration kit.
- A standard "class" is a grouping of one or more standards that determines which of the eight standards are used at each step of the calibration. For example, standard number 2 and 8 usually makes up the S_{11}A reflection class, which for type-N calibration kits are male and female shorts.

Verify Performance

Once a measurement calibration has been generated with a user-defined calibration kit, its performance should be checked before making device measurements. To check the accuracy that can be obtained using the new calibration kit, a device with a well-defined frequency response (preferably unlike any of the standards used) should be measured. The verification device must not be one of the calibration standards: measurement of one of these standards is merely a measure of repeatability. To achieve more complete verification of a particular measurement calibration, accurately known verification standards with a diverse magnitude and phase response should be used, such as the N1011A Verification Kit. National standard traceable or Agilent standards are recommended to achieve verifiable measurement accuracy.

NOTE The published specifications for this network analyzer system include accuracy enhancement with compatible calibration kits. Measurement calibrations made with user-defined or modified calibration kits are not subject to the analyzer specifications, although a procedure similar to the system verification procedure may be used.

GPIB Operation

This section contains information on the following topics:

- local key
- GPIB controller modes
- instrument addresses
- using the parallel port

Local, Key

This key is allows you to return the analyzer to local (front panel) operation from remote (computer controlled) operation. This key will also abort a test sequence or hardcopy print/plot. In this local mode, with a controller still connected on GPIB, you can operate the analyzer manually (locally) from the front panel. This is the only front panel key that is not disabled when the analyzer is remotely controlled over GPIB by a computer. The exception to this is when local lockout is in effect: this is a remote command that disables the **Local,** key, making it difficult to interfere with the analyzer while it is under computer control.

In addition, the **Local,** key accesses the GPIB menu, where you can set the controller mode, and to the address menu, where you can enter the GPIB addresses of peripheral devices and select plotter/printer ports. You can also set the mode of the parallel port here.

The GPIB menu consists of the following softkeys:

- SYSTEM CONTROLLER,
- TALKER/LISTENER,
- USE PASS CONTROL,
- SET ADDRESS,
- PARALLEL [ ],
- GPIB DIAG on OFF,
- DISK UNIT NUMBER,
- VOLUME NUMBER,

The analyzer is factory-equipped with a remote programming interface using the General Purpose Interface Bus (GPIB). This enables communication between the analyzer and a controlling computer as well as other peripheral devices. This menu indicates the present GPIB controller mode of the analyzer. Three GPIB modes are possible: system controller, talker/listener, and pass control.

GPIB STATUS Indicators

When the analyzer is connected to other instruments over GPIB, the GPIB STATUS indicators in the instrument state function block light up to display the current status of the analyzer.

R = remote operation

L = listen mode

T = talk mode

S = service request (SRQ) asserted by the analyzer

System Controller Mode

The **SYSTEM CONTROLLER,** softkey activates the system controller mode. When in this mode, the analyzer can use GPIB to control compatible peripherals, without the use of an external computer. It can output measurement results directly to a compatible printer or plotter, store instrument states using a compatible disk drive, or control a power meter for performing service routines. The power meter calibration function requires system controller or pass control mode.

Talker/Listener Mode

The **TALKER/LISTENER,** softkey activates the talker/listener mode, which is the mode of operation most often used. In this mode, a computer controller communicates with the analyzer and other compatible peripherals over the bus. The computer sends commands or instructions to and receives data from the analyzer. All of the capabilities available from the analyzer front panel can be used in this remote operation mode, except for control of the power line switch and some internal tests.

Pass Control Mode

The **USE PASS CONTROL,** softkey activates the third mode of GPIB operation: the pass control mode. In an automated system with a computer controller, the controller can pass control of the bus to the analyzer on request from the analyzer. The analyzer is then the controller of the peripherals, and can direct them to plot, print, or store without going through the computer. When the peripheral operation is complete, control is passed back to the computer. Only one controller can be active at a time. The computer remains the system controller, and can regain control at any time.

Preset does not affect the selected controller mode, but cycling the power returns the analyzer to talker/listener mode.

Information on compatible peripherals is provided in the “Options and Accessories” chapter of the reference guide.

Address Menu

This menu can be accessed by pressing the **SET ADDRESS,** softkey within the GPIB menu. In communications through the General Purpose Interface Bus (GPIB), each instrument on the bus is identified by a GPIB address. This decimal-based address code must be different for each instrument on the bus. This menu lets you set the GPIB address of the analyzer, and enter the addresses of peripheral devices so that the analyzer can communicate with them. Most of the GPIB addresses are set at the factory and need not be modified for normal system operation. The standard factory-set addresses for instruments that may be part of the system are as follows:

Instrument	GPIB Address (decimal)
Analyzer	16
Plotter	05
Printer	01
External Disk Drive	00
Controller	21
Power Meter	13

The address displayed in this menu for each peripheral device must match the address set on the device itself. The analyzer does not have a GPIB switch: its address is set only from the front panel. These addresses are stored in non-volatile memory and are not affected by preset or by cycling the power.

Using the Parallel Port

The instrument's parallel port can be used in two different modes. By pressing **Local,** and then toggling the **PARALLEL [ ],** softkey, you can select either the **[COPY],** mode or the **[GPIO],** mode.

The Copy Mode

The copy mode allows the parallel port to be connected to a printer or plotter for the outputting of test results. To use the parallel port for printing or plotting, you must do the following:

1. Press **Local, SET ADDRESSES.**
2. Select either **PLOTTER PORT,** or **PRINTER PORT.**
3. Select **PARALLEL,** so that copy is underlined.

The GPIO Mode

The GPIO mode turns the parallel port into a "general purpose input/output" port.

In this mode the port can be connected to test fixtures, power supplies, and other peripheral equipment that might be used to interact with the analyzer during measurements. This mode is exclusively used in test sequencing.

Limit Line Operation

This menu can be accessed by pressing **LIMIT MENU, LIMIT LINE,** within the system menu. You can have limit lines drawn on the display to represent upper and lower limits or device specifications with which to compare the test device. Limits are defined in segments, where each segment is a portion of the stimulus span. Each limit segment has an upper and a lower starting limit value. Three types of segments are available: flat line, sloping line, and single point. Limits can be defined independently for the four channels, up to 22 segments for each channel. These can be in any combination of the three limit types.

Limit testing compares the measured data with the defined limits, and provides pass or fail information for each measured data point. An out-of-limit test condition is indicated in five ways: with a `FAIL` message on the screen, with a beep, by changing the color of the failing portions of a trace, with an asterisk in tabular listings of data, and with a bit in the GPIB event status register B. (The analyzer also has a BNC rear panel output that includes this status, but is only valid for a single channel measurement.) The limit test output has three selectable modes.

Limit lines and limit testing can be used simultaneously or independently. If limit lines are on and limit testing is off, the limit lines are shown on the display for visual comparison and adjustment of the measurement trace. However, no pass/fail information is provided. If limit testing is on and limit lines are off, the specified limits are still valid and the pass/fail status is indicated even though the limit lines are not shown on the display.

Limits are entered in tabular form. Limit lines and limit testing can be either on or off while limits are defined. As new limits are entered, the tabular columns on the display are updated, and the limit lines (if on) are modified to the new definitions. The complete limit set can be offset in either stimulus or amplitude value.

Limits are checked only at the actual measured data points. It is possible for a device to be out of specification without a limit test failure indication if the point density is insufficient. Be sure to specify a high enough number of measurement points in the stimulus menu.

Limit lines are displayed only on Cartesian formats. In polar and Smith chart formats, limit testing of one value is available: the value tested depends on the marker mode and is the magnitude or the first value in a complex pair. The message `NO LIMIT LINES DISPLAYED` is shown on the display in polar and Smith chart formats.

The list values feature in the copy menu provides tabular listings to the display or a printer for every measured stimulus value. These include limit line or limit test information if these functions are activated. If limit testing is on, an asterisk is listed next to any measured value that is out of limits. If limit lines are on, and other listed data allows sufficient space, the upper limit and lower limit are listed, together with the margin by which the device data passes or fails the nearest limit.

If limit lines are on, they are plotted with the data on a plot. If limit testing is on, the `PASS` or `FAIL` message is plotted, and the failing portions of the trace that are a different color on the display are also a different color on the plot. If limits are specified, they are saved in memory with an instrument state.

Edit Limits Menu

This menu allows you to specify limits for limit lines or limit testing, and presents a table of limit values on the display. Limits are defined in segments. Each segment is a portion of the stimulus span. Up to 22 limit segments can be specified for each channel. The limit segments do not have to be entered in any particular order: the analyzer automatically sorts them and lists them on the display in increasing order of start stimulus value.

For each segment, the table lists the segment number, the starting stimulus value, upper limit, lower limit, and limit type. The ending stimulus value is the start value of the next segment, or a segment can be terminated with a single point segment. You can enter limit values as upper and lower limits or delta limits and middle value. As new limit segments are defined, the tabular listing is updated. If limit lines are switched on, they are shown on the display.

If no limits have been defined, the table of limit values shows the notation EMPTY. Limit segments are added to the table using the **ADD,** softkey or edited with the **EDIT,** softkey, as previously described. The last segment on the list is followed by the notation END.

Edit Segment Menu

This menu sets the values of the individual limit segments. The segment to be modified, or a default segment, is selected in the edit limits menu. The stimulus value can be set with the controls in the entry block or with a marker (the marker is activated automatically when this menu is presented). The limit values can be defined as upper and lower limits, or delta limits and middle value. Both an upper limit and a lower limit (or delta limits) must be defined: if only one limit is required for a particular measurement, force the other out of range (for example +500 dB or –500 dB).

As new values are entered, the tabular listing of limit values is updated. Segments do not have to be listed in any particular order: the analyzer sorts them automatically in increasing order of start stimulus value when the **DONE,** key in the edit limits menu is pressed. However, the easiest way to enter a set of limits is to start with the lowest stimulus value and define the segments from left to right of the display, with limit lines turned on as a visual check. Phase limit values can be specified between +500° and –500°. Limit values above +180° and below –180° are mapped into the range of –180° to +180° to correspond with the range of phase data values.

Offset Limits Menu

This menu allows the complete limit set to be offset in either stimulus value or amplitude value. This is useful for changing the limits to correspond with a change in the test setup, or for device specifications that differ in stimulus or amplitude. It can also be used to move the limit lines away from the data trace temporarily for visual examination of trace detail.

6

Error Messages

Introduction

This chapter contains the following information to help you interpret any error messages that may be displayed on the analyzer LCD or transmitted by the instrument over GPIB:

An alphabetical listing of all error messages, including:

- An explanation of the message
- Suggestions to help solve the problem
- A numerical listing of all error messages

Some messages described in this chapter are for information only and do not indicate an error condition. These messages are not numbered and so they will not appear in the numerical listing.

Error Messages in Alphabetical Order

ABORTING COPY OUTPUT. Information Message. This message is displayed briefly if you have pressed Local, to abort a copy operation. If the message is not subsequently replaced by error message number 25, PRINT ABORTED (or PLOT ABORTED) the copy device may be hung. Press Local, once more to exit the abort process and verify the status of the copy device. At this point, the copy device will probably have an error condition which must be fixed. (For example: out of paper or paper jam.)

ADDITIONAL STANDARDS NEEDED. Error Number 68. Error correction for the selected calibration class cannot be computed until you have measured all the necessary standards.

ADDRESSED TO TALK WITH NOTHING TO SAY. Error Number 31. You have sent a read command to the analyzer (such as ENTER 716) without first requesting data with an appropriate output command (such as OUTPDATA). The analyzer has no data in the output queue to satisfy the request.

ALL REGISTERS HAVE BEEN USED. Error Number 200. You have used all of the available registers; you can store no more instrument states even though you may still have sufficient memory. There are 31 registers available, plus the preset instrument state.

ANALOG BUS DISABLED IN 6 KHZ IF BW. Error Number 212. When you press Avg, IF BW [6000], the analog bus is disabled and not available for use in troubleshooting. For a description of the analog bus, refer to the service guide.

ANALOG INPUT OVERLOAD. Error Number 60. The power level of the analog input is too high. Reduce the power level of the analog input source.

ANOTHER SYSTEM CONTROLLER ON GPIB. Error Number 37. You must remove the active controller from the bus or the controller must relinquish the bus before the analyzer can assume the system controller mode.

ARGUMENT OUT OF RANGE. Error Number 206. The argument for a programming command is out of the specified range. Refer to the programmer's guide for a list of programming commands and argument ranges.

ASCII: MISSING 'BEGIN' STATEMENT. Error Number 193. The CITIfile you just downloaded over the GPIB or via disk was not properly organized. The analyzer is unable to read the “BEGIN” statement.

ASCII: MISSING 'CITIFILE' STATEMENT. Error Number 194. The CITIfile you just downloaded over the GPIB or via disk was not properly organized. The analyzer is unable to read the “CITIFILE” statement.

ASCII: MISSING 'DATA' STATEMENT. Error Number 195. The CITIfile you just downloaded over the GPIB or via disk was not properly organized. The analyzer is unable to read the “DATA” statement.

ASCII: MISSING 'VAR' STATEMENT. Error Number 196. The CITIfile you just downloaded over the GPIB or via disk was not properly organized. The analyzer is unable to read the “VAR” statement.

AUTOBIAS IS TURNED OFF. Information Message. The modulator bias mode is switched off , either manually or due to insufficient signal for bias adjust. Autobiasing can be switched on in the Service Menu and it is advised to switch autobias ON when making O/O and O/E measurements.

AVERAGING INVALID ON NON-RATIO MEASURE. Error Number 13. You cannot use sweep-to-sweep averaging in single-input measurements. Sweep-to-sweep averaging is valid only for ratioed measurements (A/R, B/R, A/B, and S-parameters). You can use other noise reduction techniques, such as narrower IF bandwidth, for single input measurements.

BAD FREQ FOR HARMONIC. Error Number 181. You recalled a calibration that resulted in start and stop frequencies that are beyond the allowable limits.

BANDWIDTH LIMIT INVALID: MIN BW > MAX BW. Information Message. The bandwidth test has a minimum bandwidth greater than the maximum bandwidth. Change the minimum bandwidth to a frequency less than the frequency of the maximum bandwidth or change the maximum bandwidth to a frequency greater than the frequency of the minimum bandwidth

BATTERY FAILED. STATE MEMORY CLEARED. Error Number 183. The battery protection of the non-volatile CMOS memory has failed. The CMOS memory has been cleared. Refer to Chapter 8, “Preset State and Memory Allocation” for more information about the CMOS memory.

BATTERY LOW! STORE SAVE REGS TO DISK. Error Number 184. The battery protection of the non-volatile CMOS memory is in danger of failing. If this occurs, all of the instrument state registers stored in CMOS memory will be lost. Save these states to a disk. Refer to Chapter 8, “Preset State and Memory Allocation” for more information about the CMOS memory.

BLOCK INPUT ERROR. Error Number 34. The analyzer did not receive a complete data transmission. This is usually caused by an interruption of the bus transaction. Clear by pressing the Local, key or aborting the I/O process at the controller.

BLOCK INPUT LENGTH ERROR. Error Number 35. The length of the header received by the analyzer did not agree with the size of the internal array block. Refer to the programmer’s guide for instructions on using analyzer input commands.

CALIBRATION ABORTED. Error Number 74. You have changed the active channel during a calibration, so the calibration in progress was terminated. Make sure the appropriate channel is active and restart the calibration.

CALIBRATION REQUIRED. Error Number 63. A calibration set could not be found that matched the current stimulus state or measurement parameter. You will have to perform a new calibration.

CANNOT FORMAT DOS DISKS ON THIS DRIVE. Error Number 185. You have attempted to initialize a floppy disk to DOS format on an external disk drive that does not support writing to all 80 tracks of the double density and high density disks. The older single-sided disks had only 66 tracks and some disk drives were limited to accessing that number of tracks. To format the disk, either choose another external disk drive or use the analyzer's internal disk drive.

CANNOT MODIFY FACTORY PRESET. Error Number 199. You have attempted to rename, delete, or otherwise alter the factory preset state. The factory preset state is permanently stored in ROM and cannot be altered. If your intent was to create a user preset state, you must create a new instrument state, save it, and then rename it to "UPRESET". Refer to Chapter 8, "Preset State and Memory Allocation" for more detailed instructions.

CANNOT READ/WRITE HFS FILE SYSTEM. Error Number 203. The disk is being accessed by the analyzer and is found to contain an HFS (hierarchical file system) or files nested within subdirectories. The analyzer does not support HFS. Replace the disk medium with a LIF or DOS formatted disk that does not contain files nested within subdirectories.

CAN'T STORE/LOAD SEQUENCE, INSUFFICIENT MEMORY. Error Number 127. Your sequence transfer to or from a disk could not be completed due to insufficient memory.

CAUTION: CORRECTION OFF: AUX CHANNEL(S) DISABLED. Error Number 215. This message is displayed when correction is forced off due to a stimulus change that is not compatible with the current calibration while an auxiliary channel is enabled. The auxiliary channels are restored when correction is turned on by pressing Cal, CORRECTION on OFF.

CAUTION: FLOPPY DISK IS FULL. Error Number 218. This message is displayed if you try to save files to the floppy disk that does not have enough memory to perform the save task. Correct by inserting a new floppy disk in the front panel disk drive or by erasing files from the current floppy disk.

CAUTION: INSUFFICIENT SIGNAL FOR BIAS ADJUST. Information Message. This message is displayed when the optical power is too low to perform an auto bias. The common causes of this message are dirty or poor optical connectors, defective optical cables, and the safety interlock port at the rear of the test set.

CAUTION: LASER KEY SWITCH IS TURNED OFF. Information Message. Refer to the LASER SOFTKEY IS OFF error message description.

CAUTION: LASER SOFTKEY IS OFF. Information Message. This message is usually displayed when you are trying to make an optical measurement when the laser softkey is set to OFF. The message will also be displayed if the auto bias timer instructs the instrument to perform the auto bias routine. You can disable the auto bias timer by pressing System, Service Menu, Lightwave Menu, Bias Mode Auto/OFF.

CAUTION: LW TEST SET MISSING. Information Message. This message indicates that the unit is unable to communicate with the lightwave test set. The probable causes are no power to the lightwave test set, and the 25-pin test set interconnect cable is not connected properly.

CAUTION: TOO MANY SEGMENTS OR POINTS. Information Message. This message is displayed if you try to insert too many segments or points using your current function.

CH1 (CH2, CH3, CH4) TARGET VALUE NOT FOUND. Error Number 159. Your target value for the marker search function does not exist on the current data trace.

CONTINUOUS SWITCHING NOT ALLOWED. Error Number 10. Your current measurement requires different power ranges on channel 1 and channel 2. To protect the attenuator from undue mechanical wear, test set hold will be activated. The “tsH” (test set hold) indicator in the left margin of the display indicates that the inactive channel has been put in the sweep hold mode.

This message is also displayed if a mechanical switch test set is in use and channels are measuring parameters that require the test set to switch continuously, for example S11 on Channel 1 and S22 on Channel 2

COPY: device not responding; copy aborted. Error Number 170. The printer or plotter is not accepting data. Verify the cable connections, GPIB addresses, and otherwise ensure that the copy device is ready.

COPY OUTPUT COMPLETED. Information Message. The analyzer has completed outputting data to the printer or plotter. The analyzer can now accept another copy command.

CORRECTION TURNED OFF. Error Number 66. Critical parameters in your current instrument state do not match the parameters for the calibration set, therefore correction has been turned off. The critical instrument state parameters are sweep type, start frequency, frequency span, and number of points.

CURRENT PARAMETER NOT IN CAL SET. Error Number 64. Correction is not valid for your selected measurement parameter. Either change the measurement parameters or perform a new calibration.

D2/D1 INVALID WITH SINGLE CHANNEL. Error Number 130. You can only make a D2/D1 measurement if both channels are on.

D2/D1 INVALID: CH1 CH2 NUM PTS DIFFERENT. Error Number 152. You can only make a D2/D1 measurement if both channels have the same number of points.

DEADLOCK. Error Number 111. A fatal firmware error occurred before instrument preset completed. Call your local Agilent Technologies sales and service office.

DEMODULATION NOT VALID. Error Number 17. Demodulation was selected when the analyzer was not in CW time mode. Select demodulation only after putting the analyzer into CW time mode.

DEVICE: not on, not connect, wrong addrs. Error Number 119. The device at the selected address cannot be accessed by the analyzer. Verify that the device is switched on, and check the GPIB connection between the analyzer and the device. Ensure that the device address recognized by the analyzer matches the GPIB address set on the device itself.

DIRECTORY FULL. Error Number 188. There is no room left in the directory to add files. Either delete files or get a new disk.

DISK HARDWARE PROBLEM. Error Number 39. The disk drive is not responding correctly. If using an external disk drive, refer to the disk drive operating manual.

DISK IS WRITE PROTECTED. Error Number 48. The store operation cannot write to a write-protected disk. Slide the write-protect tab over the write-protect opening in order to write data on the disk.

DISK MEDIUM NOT INITIALIZED. Error Number 40. You must initialize the disk before it can be used.

DISK MESSAGE LENGTH ERROR. Error Number 190. The analyzer and the external disk drive aren't communicating properly. Check the GPIB connection and then try substituting another disk drive to isolate the problem instrument.

DISK: not on, not connected, wrong addrs. Error Number 38. The disk cannot be accessed by the analyzer. Verify power to the disk drive, and check the GPIB connection between the analyzer and the disk drive.

Ensure that the disk drive address recognized by the analyzer matches the GPIB address set on the disk drive itself.

DISK READ/WRITE ERROR. Error Number 189. There may be a problem with your disk. Try a new floppy disk. If a new floppy disk does not eliminate the error, suspect hardware problems.

DISK WEAR - REPLACE DISK SOON. Error Number 49. Cumulative use of the disk is approaching the maximum. Copy files as necessary using an external controller. If no controller is available, load instrument states from the old disk and store them to a newly initialized disk using the save/recall features of the analyzer. Discard the old disk.

DUPLICATING TO THIS SEQUENCE NOT ALLOWED. Error Number 125. A sequence cannot be duplicated to itself.

EXCEEDED 7 STANDARDS PER CLASS. Error Number 72. When modifying calibration kits, you can define a maximum of seven standards for any class.

FACTORY CAL ARRAY X IS NOT FOUND. Information Message. Improper firmware usage. The analyzer needs to be recalibrated if this message persists. The results of lightwave measurements will be erroneous. Contact your nearest Agilent office if this message persists.

FILE NOT COMPATIBLE WITH INSTRUMENT. Information Message. You cannot recall user graphics that had been saved on an earlier model of analyzer with a monochrome display. These files cannot be used with the analyzer.

FILE NOT FOUND. Error Number 192. The requested file was not found on the current disk medium.

FILE NOT FOUND OR WRONG TYPE. Error Number 197. During a recall operation, either the file was not found or the type of file was not an instrument state file.

FIRST CHARACTER MUST BE A LETTER. Error Number 42. The first character of a disk file title or an internal save register title must be an alpha character.

FORMAT NOT VALID FOR MEASUREMENT. Error Number 75. Conversion measurements (Z or Y reflection and transmission) are not valid with Smith chart and SWR formats.

FORMATTING DATA. Information Message. The list information is being processed for a list data output to a copy device and stored in the copy spool buffer. During this time, the analyzer's resources are dedicated to this task (which takes less than a few seconds).

FUNCTION NOT AVAILABLE. Error Number 202. The function you requested over GPIB is not available on the current instrument.

FUNCTION NOT VALID. Error Number 14. The function you requested is incompatible with the current instrument state.

FUNCTION NOT VALID DURING MOD SEQUENCE. Error Number 131. You cannot perform sequencing operations while a sequence is being modified.

FUNCTION NOT VALID FOR INTERNAL MEMORY. Error Number 201. The function you selected only works with disk files.

FUNCTION ONLY VALID DURING MOD SEQUENCE. Error Number 163. You can only use the GOSUB

SEQUENCE, capability when you are building a sequence. Attempting to use this softkey at any other time returns an error message and no action is taken.

8703 SOURCE PARAMETERS CHANGED. Error Number 61. Some of the stimulus parameters of the instrument state have been changed, because you have turned correction on. A calibration set for the current measurement parameter was found and activated. The instrument state was updated to match the stimulus parameters of the calibration state.

GPIB COPY IN PROGRESS, ABORT WITH LOCAL. Error Number 169. An GPIB copy was already in progress when you requested the GPIB for another function. To abort the first copy, press Local, otherwise the GPIB is unavailable until the first copy is completed.

IF BW KEY DISABLED, EDIT LIST MODE TBL. Information Message. When list IF bandwidth has been enabled and swept list mode is on, you will not be able to change the IF bandwidth using the IF BW, key. To change the IF bandwidth, edit the swept list table.

ILLEGAL UNIT OR VOLUME NUMBER. Error Number 46. The disk unit or volume number set in the analyzer is not valid. Refer to the disk drive operating manual.

INIT DISK removes all data from disk. Information Message. Continuing with the initialize operation will destroy any data currently on the disk.

INITIALIZATION FAILED. Error Number 47. The disk initialization failed, probably because the disk is damaged.

INSTRUMENT STATE MEMORY CLEARED. Error Number 56. All instrument state registers have been cleared from memory along with any saved calibration data, memory traces, and calibration kit definitions. Additionally, all user-settable selections (such as GPIB addresses) are set to their defaults.

INSUFFICIENT MEMORY. Error Number 51. Your last front panel or GPIB request could not be implemented due to insufficient memory space. In some cases, this is a fatal error from which you can escape only by presetting the instrument.

INSUFFICIENT MEMORY FOR PRINT/PLOT. Error Number 168. There is not enough memory available for the print or plot function. Increase the available memory by changing or eliminating a memory-intensive operation such as reducing the number of points in the sweep.

INSUFFICIENT SIGNAL FOR BIAS ADJUST. Information Message. Autobias failed due to lack of enough laser power to the modulator. Check that the jumper is not removed. Contact your nearest Agilent office if this message persists.

INSUFFICIENT MEMORY, PWR MTR CAL OFF. Error Number 154. There is not enough memory space for the power meter calibration array. Increase the available memory by clearing one or more save/recall registers, or by reducing the number of points.

INVALID KEY. Error Number 2. An invalid key was attempted; there may be a possible hardware failure.

ISOL AVERAGES < SWP AVERAGES. Error Number 223. The isolation averages are less than the instrument sweep averages. Increase the isolation averages to be equal to or greater than instrument sweep averages. This error can only occur when instrument averaging is turned on.

LASER TEMPERATURE LOOP OPEN. Error Number 219. The laser temperature is unstable. (This message may appear for the first few minutes when the analyzer is powered up.) Cycle the analyzer power and allow a warm-up time of two hours, then press any key. If the message persists, contact your nearest Agilent office.

LIMIT TABLE EMPTY. Error Number 205. Limit lines cannot be turned on unless a limit table has been created. Refer to the “Making Measurements” chapter of the user’s guide for information on how to create a limit table.

LIST TABLE EMPTY. Error Number 9. The frequency list is empty. To implement list frequency mode, add segments to the list table.

LOG SWEEP REQUIRES 2 OCTAVE MINIMUM SPAN. Error Number 150. A logarithmic sweep is only valid if the stop frequency is greater than four times the start frequency. For frequency spans of less than two octaves, the sweep type automatically reverts to linear sweep.

LW TESTSET MISSING. Error Number 224. The lightwave testset may be powered down separately, or the cable at the rear panel may be removed or loose.

MEMORY FOR CURRENT SEQUENCE IS FULL. Error Number 132. All the memory in the sequence you are modifying is filled with instrument commands.

MODULATOR TEMPERATURE LOOP OPEN. Error Number 220. The modulator temperature is unstable. (This message may appear for the first few minutes when the analyzer is powered up.) Cycle the analyzer power and allow a warm-up time of two hours, then press any key. If the message persists, contact your nearest Agilent office.

MORE SLIDES NEEDED. Error Number 71. When you use a sliding load (in a user-defined calibration kit), you must set at least three slide positions to complete the calibration.

NO CALIBRATION CURRENTLY IN PROGRESS. Error Number 69. The RESUME CAL SEQUENCE, softkey is not valid unless a calibration is already in progress. Start a new calibration.

NO DISK MEDIUM IN DRIVE. Error Number 41. You have no disk in the current disk unit. Insert a disk, or check the disk unit number stored in the analyzer.

NO FAIL FOUND.Service Error Number 114. The self-diagnose function of the instrument operates on an internal test failure. At this time, no failure has been detected.

NO FILE(S) FOUND ON DISK. Error Number 45. No files of the type created by an analyzer store operation were found on the disk or the disk drive is empty. If you requested a specific file title, that file was not found on the disk.

NO IF FOUND: CHECK R INPUT LEVEL. Error Number 5. The first IF signal was not detected during pretune. Check the front panel R channel jumper. If there is no visible problem with the jumper, refer to the service guide for troubleshooting.

NO LIMIT LINES DISPLAYED. Error Number 144. You can turn limit lines on but they cannot be displayed on polar or Smith chart display formats.

NO MARKER DELTA - SPAN NOT SET. Error Number 15. You must turn the delta marker mode on, with at least two markers displayed, in order to use the MARKER -> SPAN, softkey function.

NO MEMORY AVAILABLE FOR INTERPOLATION. Error Number 123. You cannot perform interpolated error correction due to insufficient memory.

NO MEMORY AVAILABLE FOR SEQUENCING. Error Number 126. You cannot modify the sequence due to insufficient memory.

NO SPACE FOR NEW CAL. CLEAR REGISTERS. Error Number 70. You cannot store a calibration set due to insufficient memory. You can free more memory by clearing a saved instrument state from an internal register (which may also delete an associated calibration set, if all the instrument states using the calibration set have been deleted). You can store the saved instrument state and calibration set to a disk before clearing them. After deleting the instrument states, press Preset, to run the memory packer.

NOT ALLOWED DURING POWER METER CAL. Error Number 198. When the analyzer is performing a power meter calibration, the GPIB bus is unavailable for other functions such as printing or plotting.

NOT ENOUGH SPACE ON DISK FOR STORE. Error Number 44. The store operation will overflow the available disk space. Insert a new disk or purge files to create free disk space.

NO VALID MEMORY TRACE. Error Number 54. If you are going to display or otherwise use a memory trace, you must first store a data trace to memory.

NO VALID STATE IN REGISTER. Error Number 55. You have requested the analyzer, over GPIB (or by sequencing), to load an instrument state from an empty internal register.

ONLY LETTERS AND NUMBERS ARE ALLOWED. Error Number 43. You can only use alpha-numeric characters (and underscores) in disk file titles or internal save register titles. Other symbols are not allowed, except for the “underscore” symbol.

OVER ILLUMINATION IN OPTICAL INPUT. Warning Message. This message warns that too much optical power is entering the OPTICAL RECEIVER INPUT. If optical power is not reduced, damage may occur.

OVERLAP! LIST TYPE CHANGED TO STEPPED. Error Number 211. The list type changed to stepped because one or more frequency segments in the swept list table overlapped. Change the frequency ranges of the overlapping segments and switch back to swept list mode.

OVERLOAD ON INPUT A, POWER REDUCED . Error Number 58. See OVERLOAD ON INPUT R, POWER REDUCED (error number 57).

OVERLOAD ON INPUT B, POWER REDUCED . Error Number 59. See OVERLOAD ON INPUT R, POWER REDUCED (error number 57).

OVERLOAD ON INPUT R, POWER REDUCED. Error Number 57. You have exceeded approximately +14 dBm at one of the test ports. The RF output power is automatically reduced to -85 dBm. The annotation P? appears in the left margin of the display to indicate that the power trip function has been activated. When this occurs, reset the power to a lower level, then toggle the softkey to switch on the power again.

PARALLEL PORT NOT AVAILABLE FOR GPIO. Error Number 165. You have defined the parallel port as COPY for printing in the GPIB menu. To access the parallel port for general purpose I/O (GPIO), set the selection to PARALLEL [GPIO].

PARALLEL PORT NOT AVAILABLE FOR COPY. Error Number 167. You have defined the parallel port as general purpose I/O (GPIO) for sequencing. The definition was made under the Local, key menus. To access the parallel port for copy, set the selection to PARALLEL [COPY].

PHASE LOCK CAL FAILED. Error Number 4. An internal phase lock calibration routine is automatically executed at power-on, preset, and any time a loss of phase lock is detected. This message indicates that phase lock calibration was initiated and the first IF detected, but a problem prevented the calibration from completing successfully.

PHASE LOCK FAILURE. Error Number 7. The first IF signal was detected at pretune, but phase lock could not be acquired. Check the signal level to the R channel input to make sure it is -35 dBm or higher.

PHASE LOCK LOST. Error Number 8. Phase lock was acquired but then lost.

PLOT ABORTED. Error Number 27. When you press the Local, key, the analyzer aborts the plot in progress.

PLOTTER: not on, not connect, wrong addrs. Error Number 26. The plotter does not respond to control. Verify power to the plotter, and check the GPIB connection between the analyzer and the plotter. Ensure that the plotter address recognized by the analyzer matches the GPIB address set on the plotter itself.

PLOTTER NOT READY-PINCH WHEELS UP. Error Number 28. The plotter pinch wheels clamp the paper in place. If you raise the pinch wheels, the plotter indicates a “not ready” status on the bus.

POSSIBLE FALSE LOCK. Error Number 6. Phase lock has been achieved, but the source may be phase locked to the wrong harmonic of the synthesizer.

POWER METER INVALID. Error Number 116. The power meter indicates an out-of-range condition. Check the test setup.

POWER METER NOT SETTLED. Error Number 118. Sequential power meter readings are not consistent. Verify that the equipment is set up correctly. If so, preset the instrument and restart the operation.

POWER OUT MAY BE UNLEVELED. Error Number 179. There is either a hardware failure in the source or you have attempted to set the power level too high. The analyzer allows the output power to be set higher or lower than the specified available power range. However, these output powers may be un-leveled or unavailable. Check to see if the power level you set is within specifications.

POWER SUPPLY HOT!. Error Number 21. The temperature sensors on the A8 post-regulator assembly have detected an over-temperature condition. The power supplies regulated on the post-regulator have been shut down.

POWER SUPPLY SHUT DOWN!. Error Number 22. One or more supplies on the A8 post-regulator assembly have been shut down due to an over-current, over-voltage, or under-voltage condition.

PRINT ABORTED. Error Number 25. When you press the Local, key, the analyzer aborts output to the printer.

print color not supported with EPSON. Error Number 178. You have defined the printer type as EPSON-P2. Color print is not supported with this printer. The print will abort.

PRINTER: busy. Error Number 176. The parallel port printer is not accepting data.

PRINTER: error. Error Number 175. The parallel port printer is malfunctioning. The analyzer cannot complete the copy function.

PRINTER: not connected. Error Number 173. There is no printer connected to the parallel port.

PRINTER: not handshaking. Error Number 177. The printer at the parallel port is not responding.

PRINTER: not on line. Error Number 172. The printer at the parallel port is not set on line.

PRINTER: not on, not connected, wrong addrs. Error Number 24. The printer does not respond to control. Verify power to the printer, and check the GPIB connection between the analyzer and the printer. Ensure that the printer address recognized by the analyzer matches the GPIB address set on the printer itself.

PRINTER: paper error. Error Number 171. There is a paper-related problem with the parallel port printer such as a paper jam or out-of-paper condition.

PRINTER: power off. Error Number 174. The power to the printer at the parallel port is off.

PRINTER: reset in progress. Information Message. If the printer takes longer than a half-second to reset, this message will be displayed until printer is finished with reset.

PRINT/PLOT IN PROGRESS, ABORT WITH LOCAL. Error Number 166. If a print or plot is in progress and you attempt a second print or plot, this message is displayed and the second attempt is ignored. To abort a print or plot in progress, press Local.

PROCESSING DISPLAY LIST. Information Message. The display information is being processed for a screen print to a copy device and stored in the copy spool buffer. During this time, the analyzer's resources are dedicated to this task (which takes less than a few seconds).

PWR MTR NOT ON/CONNECTED OR WRONG ADDRS. Error Number 117. The power meter cannot be accessed by the analyzer. Verify that the power meter address and model number set in the analyzer match the address and model number of the actual power meter.

RANGE CAUSED POWER LVL CHANGE IN LIST. Error Number 213. The selected power range changed the power level of one or more segments in the swept list table. Change the segment power or change the power range.

RECEIVER TEMPERATURE LOOP OPEN. Error Number 219. The receiver temperature is unstable. (This message may appear for the first few minutes when the analyzer is powered up.) Cycle the analyzer power and allow a warm-up time of two hours, then press any key. If the message persists, contact your nearest Agilent office.

REQUESTED DATA NOT CURRENTLY AVAILABLE. Error Number 30. The analyzer does not currently contain the data you have requested. For example, this condition occurs when you request error term arrays and no calibration is active.

RIPPLE LIMIT TABLE EMPTY. Information Message. The ripple limit table does not have any frequency bands defined. Add at least one frequency band to the ripple limit table for ripple testing.

SAVE FAILED. INSUFFICIENT MEMORY. Error Number 151. You cannot store an instrument state in an internal register due to insufficient memory. Increase the available memory by clearing one or more save/recall registers and pressing Preset, or by storing files to a disk.

SEGMENT #n POWER OUTSIDE RANGE LIMIT. Information Message. The selected power range does not support the power level of one or more segments in the swept list table. This message appears when swept list mode is not on and reports the first segment that is out of range. Change the segment power or change the power range.

SEGMENT #n START FREQ OVERLAPS PREVIOUS SEGMENT. Information Message. A segment entered in the swept list table caused one or more frequency segments to overlap. This message appears when swept list mode is not on and reports the first segment that is overlapping another. Change the frequency ranges of the overlapping segments.

SELECTED SEQUENCE IS EMPTY. Error Number 124. The sequence you attempted to run does not contain instrument commands.

SELF TEST #n FAILED. Service Error Number 112. Internal test #n has failed. Several internal test routines are executed at instrument preset. The analyzer reports the first failure detected.

SEQUENCE ABORTED. Error Number 157. The sequence running was stopped prematurely when you pressed the Local, key.

SEQUENCE MAY HAVE CHANGED, CAN'T CONTINUE. Error Number 153. When you pause a sequence, you cannot continue it if you have modified it. You must start the sequence again.

SLIDES ABORTED (MEMORY REALLOCATION). Error Number 73. You cannot perform sliding load measurements due to insufficient memory. Increase the available memory by clearing one or more save/recall registers and pressing Preset, or by storing files to a disk and then deleting them from internal memory.

SOURCE POWER DISABLED, EDIT LIST MODE TBL. Information Message. When list power has been enabled and swept list mode is on, you will not be able to change the power level using the Power, key. To change the power level, edit the swept list table.

SOURCE POWER TURNED OFF, RESET UNDER POWER MENU. Information Message. You have exceeded the maximum power level at one of the inputs and power has been automatically reduced. The annotation P? indicates that power trip has been activated. When this occurs, reset the power and then press Power, SOURCE PWR on OFF, to switch on the power.

STARTING COPY SPOOLER. Information Message. The analyzer is beginning to output data from the spool buffer to the copy device. The analyzer resumes normal operation; the data is being output to the copy device in the background.

SWEEP MODE CHANGED TO CW TIME SWEEP. Error Number 187. If you select external source auto or manual instrument mode and you do not also select CW mode, the analyzer is automatically switched to CW.

SWEEP TIME INCREASED. Error Number 11. You have made instrument changes that cause the analyzer sweep time to be automatically increased. Some parameter changes that cause an increase in sweep time are narrower IF bandwidth, an increase in the number of points, and a change in sweep type.

SWEEP TIME TOO FAST. Error Number 12. The fractional-N and digital IF circuits have lost synchronization.

SWEEP TRIGGER SET TO HOLD. Information Message. The instrument is in a hold state and is no longer sweeping. To take a new sweep, press Sweep Setup, TRIGGER MENU, SINGLE, or CONTINUOUS.

SYNTAX ERROR. Error Number 33. You have improperly formatted a GPIB command. Refer to the programmer's guide for proper command syntax.

SYST CTRL OR PASS CTRL IN LOCAL MENU. Error Number 36. The analyzer is in talker/listener mode. In this mode, the analyzer cannot control a peripheral device on the bus. Use the local menu to change to system controller or pass control mode.

TEST PORT OVERLOAD, REDUCE POWER. Error Number 57. You have exceeded approximately +14 dBm at one of the test ports (or 0 dBm at the A or B sampler, Option 012 only). When this occurs, reduce the power to a lower level.

THIS LIST FREQ INVALID. Error Number 133. You have set frequencies in the list that are outside of the allowable frequency range of the analyzer. Reduce the frequency range of the list.

TOO MANY NESTED SEQUENCES. SEQ ABORTED. Error Number 164. You can only nest sequences to a maximum level of six. The sequence will abort if you nest more than six.

TOO MANY SEGMENTS OR POINTS. Error Number 50. You can have a maximum of 30 segments or 1601 points in frequency list mode. In power meter calibrations, you can have a maximum of 12 segments for power sensor cal factors and power loss functions.

VALID ONLY FOR BILATERAL DEVICES. Information Message. This message is displayed when an enhanced reflection calibration is initiated. If the device tested is not a bilateral device, the enhanced reflection calibration will cause errors in the measurement results.

A bilateral device has similar forward and reverse transmission characteristics. Examples of bilateral devices are passive devices (filters, attenuators, and switches). Most active devices (amplifiers) and some passive devices (isolators and circulators) are not bilateral.

WAITING FOR CLEAN SWEEP. Information Message. In single sweep mode, the instrument ensures that all changes to the instrument state, if any, have been implemented before taking the sweep. The command that you have initiated is being processed and will not be complete until the new sweep is completed. An asterisk * is displayed in the left margin until a complete fresh sweep has been taken.

WAITING FOR DISK. Information Message. This message is displayed between the start and finish of a read or write operation to a disk.

WAITING FOR GPIB CONTROL. Information Message. You have instructed the analyzer to use pass control (USEPASC). When you send the analyzer an instruction that requires active controller mode, the analyzer requests control of the bus and simultaneously displays this message. If the message remains, the system controller is not relinquishing the bus.

WRITE ATTEMPTED WITHOUT SELECTING INPUT TYPE. Error Number 32. You have sent the data header "#A" to the analyzer with no preceding input command (such as INPUDATA). The instrument recognized the header but did not know what type of data to receive. Refer to the programmer's guide for command syntax information.

WRONG DISK FORMAT, INITIALIZE DISK. Error Number 77. You have attempted to store, load, or read file titles, but your disk format does not conform to the Logical Interchange Format (LIF) or DOS format. You must initialize the disk before reading or writing to it.

Error Messages in Numerical Order

Error Number	Error
2	INVALID KEY
4	PHASE LOCK CAL FAILED
5	NO IF FOUND: CHECK R INPUT LEVEL
6	POSSIBLE FALSE LOCK
7	PHASE LOCK FAILURE
8	PHASE LOCK LOST
9	LIST TABLE EMPTY
10	CONTINUOUS SWITCHING NOT ALLOWED
11	SWEEP TIME INCREASED
12	SWEEP TIME TOO FAST
13	AVERAGING INVALID ON NON-RATIO MEASURE
14	FUNCTION NOT VALID
15	NO MARKER DELTA - SPAN NOT SET
17	DEMODULATION NOT VALID
21	POWER SUPPLY HOT!
22	POWER SUPPLY SHUT DOWN!
24	PRINTER: not on, not connect, wrong addrs
25	PRINT ABORTED
26	PLOTTER: not on, not connect, wrong addrs
27	PLOT ABORTED
28	PLOTTER NOT READY-PINCH WHEELS UP
30	REQUESTED DATA NOT CURRENTLY AVAILABLE
31	ADDRESSED TO TALK WITH NOTHING TO SAY
32	WRITE ATTEMPTED WITHOUT SELECTING INPUT TYPE
33	SYNTAX ERROR
34	BLOCK INPUT ERROR
35	BLOCK INPUT LENGTH ERROR

Error Number	Error
36	SYST CTRL OR PASS CTRL IN LOCAL MENU
37	ANOTHER SYSTEM CONTROLLER ON GPIB
38	DISK: not on, not connected, wrong addrs
39	DISK HARDWARE PROBLEM
40	DISK MEDIUM NOT INITIALIZED
41	NO DISK MEDIUM IN DRIVE
42	FIRST CHARACTER MUST BE A LETTER
43	ONLY LETTERS AND NUMBERS ARE ALLOWED
44	NOT ENOUGH SPACE ON DISK FOR STORE
45	NO FILE(S) FOUND ON DISK
46	ILLEGAL UNIT OR VOLUME NUMBER
47	INITIALIZATION FAILED
48	DISK IS WRITE PROTECTED
49	DISK WEAR-REPLACE DISK SOON
50	TOO MANY SEGMENTS OR POINTS
51	INSUFFICIENT MEMORY
54	NO VALID MEMORY TRACE
55	NO VALID STATE IN REGISTER
56	INSTRUMENT STATE MEMORY CLEARED
57	OVERLOAD ON INPUT R, POWER REDUCED
58	OVERLOAD ON INPUT A, POWER REDUCED
59	OVERLOAD ON INPUT B, POWER REDUCED
60	ANALOG INPUT OVERLOAD
61	8703 SOURCE PARAMETERS CHANGED
62	NOT VALID FOR PRESENT TEST SET
63	CALIBRATION REQUIRED
64	CURRENT PARAMETER NOT IN CAL SET
66	CORRECTION TURNED OFF
68	ADDITIONAL STANDARDS NEEDED
69	NO CALIBRATION CURRENTLY IN PROGRESS

Error Number	Error
70	NO SPACE FOR NEW CAL. CLEAR REGISTERS
71	MORE SLIDES NEEDED
72	EXCEEDED 7 STANDARDS PER CLASS
73	SLIDES ABORTED (MEMORY REALLOCATION)
74	CALIBRATION ABORTED
75	FORMAT NOT VALID FOR MEASUREMENT
77	WRONG DISK FORMAT, INITIALIZE DISK
111	DEADLOCK
112	SELF TEST #n FAILED
114	NO FAIL FOUND
116	POWER METER INVALID
117	PWR MTR: NOT ON/CONNECTED OR WRONG ADDRS
118	POWER METER NOT SETTLED
119	DEVICE: not on, not connect, wrong addrs
123	NO MEMORY AVAILABLE FOR INTERPOLATION
124	SELECTED SEQUENCE IS EMPTY
125	DUPLICATING TO THIS SEQUENCE NOT ALLOWED
126	NO MEMORY AVAILABLE FOR SEQUENCING
127	CAN'T STORE/LOAD SEQUENCE, INSUFFICIENT MEMORY
130	D2/D1 INVALID WITH SINGLE CHANNEL
131	FUNCTION NOT VALID DURING MOD SEQUENCE
132	MEMORY FOR CURRENT SEQUENCE IS FULL
133	THIS LIST FREQ INVALID
144	NO LIMIT LINES DISPLAYED
145	SWEEP TYPE CHANGED TO LINEAR SWEEP
150	LOG SWEEP REQUIRES 2 OCTAVE MINIMUM SPAN
151	SAVE FAILED / INSUFFICIENT MEMORY
152	D2/D1 INVALID: CH1 CH2 NUM PTS DIFFERENT
153	SEQUENCE MAY HAVE CHANGED, CAN'T CONTINUE
154	INSUFFICIENT MEMORY, PWR MTR CAL OFF

Error Number	Error
157	SEQUENCE ABORTED
159	CH1 (CH2) TARGET VALUE NOT FOUND
163	FUNCTION ONLY VALID DURING MOD SEQUENCE
164	TOO MANY NESTED SEQUENCES. SEQ ABORTED
165	PARALLEL PORT NOT AVAILABLE FOR GPIO
166	PRINT/PLOT IN PROGRESS, ABORT WITH LOCAL
167	PARALLEL PORT NOT AVAILABLE FOR COPY
168	INSUFFICIENT MEMORY FOR PRINT/PLOT
169	GPIB COPY IN PROGRESS, ABORT WITH LOCAL
170	COPY: device not responding; copy aborted
171	PRINTER: paper error
172	PRINTER: not on line
173	PRINTER: not connected
174	PRINTER: power off
175	PRINTER: error
176	PRINTER: busy
177	PRINTER: not handshaking
178	print color not supported with EPSON
179	POWER OUT MAY BE UNLEVELED
180	DOS NAME LIMITED TO 8 CHARS + 3 CHAR EXTENSION
181	BAD FREQ FOR HARMONIC
183	BATTERY FAILED. STATE MEMORY CLEARED
184	BATTERY LOW! STORE SAVE REGS TO DISK
185	CANNOT FORMAT DOS DISKS ON THIS DRIVE
187	SWEEP MODE CHANGED TO CW TIME SWEEP
188	DIRECTORY FULL
189	DISK READ/WRITE ERROR
190	DISK MESSAGE LENGTH ERROR
192	FILE NOT FOUND
193	ASCII: MISSING 'BEGIN' statement

Error Number	Error
194	ASCII: MISSING 'CITIFILE' statement
195	ASCII: MISSING 'DATA' statement
196	ASCII: MISSING 'VAR' statement
197	FILE NOT FOUND OR WRONG TYPE
198	NOT ALLOWED DURING POWER METER CAL
199	CANNOT MODIFY FACTORY PRESET
200	ALL REGISTERS HAVE BEEN USED
201	FUNCTION NOT VALID FOR INTERNAL MEMORY
202	FUNCTION NOT AVAILABLE
203	CANNOT READ/WRITE HFS FILE SYSTEM
205	LIMIT TABLE EMPTY
206	ARGUMENT OUT OF RANGE
207	POWER OUT MAY BE UNLEVELED
208	EXT R CHAN MUST BE ON FOR FREQUENCY OFFSET MODE
209	SWEEP MUST BE STEPPED FOR FREQUENCY OFFSET MODE?
211	OVERLAP!LIST TYPE CHANGED TO STEPPED
212	ANALOG BUS DISABLED IN 6 KHZ IF BW
213	RANGE CAUSED POWER LVL CHANGE IN LIST
215	CAUTION: CORRECTION OFF: AUX CHANNEL(S) DISABLED
218	CAUTION: FLOPPY DISK IS FULL
219	LASER TEMPERATURE LOOP OPEN
220	MODULATOR TEMPERATURE LOOP OPEN
221	RECEIVER TEMPERATURE LOOP OPEN
223	ISOL AVGS < SWP AVGS

7

Options and Accessories

Options Available

Table 7-1. 8703B Lightwave Component Analyzer Options

Option	Description
81000AI	Diamond HMS-10 Connector Interface
81000FI	FC/PC Connector Interface
81000SI	DIN 47256 Connector Interface
81000VI	ST Optical Connector Interface
81000KI	SC Optical Connector Interface
131	1310 nm Wavelength Laser Source
155	1550 nm Wavelength Laser Source
830	3.5 mm Economy Calibration Kit and Test Port Cable
908	Rack Mount Kit with Mounting Flanges
913	Rack Mount Kit with Mounting Flanges and Handles
UK6	Commercial Calibration Certificate with Test Data

Service and Support Options

Agilent Technologies offers many repair and calibration options for your analyzer. Contact the nearest Agilent Technologies sales or service office for information on options available for your analyzer.

Accessories Available

For accessories not listed in this section, refer to the configuration guide for your analyzer or refer to the following Internet site:

`www.agilent.com/`

Search for 8703B in Quick Search for the current information on the Website.

Measurement Accessories

Optical Test-Port Cables

- 81101AC, HMS-10 cable, 9/125 um, 2 meters
- 11871A, PC fiber cable, 9/125 um, 1 meter
- 11871B, ST fiber cable, 9/125 um, 1 meter

- 11886A, HMS-10 cable, 9/125 um

Microwave Test-Port Cables: 3.5mm

- 85131C single, semi-rigid: 3.5-mm to 3.5-mm, 81-cm (32-in).
- 85131D set, semi-rigid: 3.5-mm to 3.5-mm, 53-cm (21-in) each.
- 85131E single, flexible: 3.5-mm to 3.5-mm, 96-cm (38-in).
- 85131F set, flexible: 3.5-mm to 3.5-mm, 53-cm (21-in) each.
- 85132C single, semi-rigid: 7-mm to 3.5-mm, 81-cm (32-in).

Microwave Test-Port Cables: 7mm

- 85132D set, semi-rigid: 7-mm to 3.5-mm, 53-cm (21-in) each.
- 85132E single, flexible: 7-mm to 3.5-mm, 96-cm (38-in).
- 85132F set, flexible: 7-mm to 3.5-mm, 53-cm (21-in) each.

Calibration Kits

Choose a kit for each connector type to be used.

- 85052B 3.5-mm standard calibration kit (0.045 to 26.5 GHz)
  Contains fixed loads, sliding loads, open and short circuits, and adapters for both connector sexes for use with 3.5-mm test-port cables. Option K11 PSC-3.5 slotless female center contact repair kit.
- 85052C 3.5-mm LTRA calibration kit (0.045 to 26.5 GHz)
  Contains fixed loads, open and short circuits, TRL lines, and adapters for both connector sexes for use with 3.5-mm test-port cables.
- 85052D 3.5-mm economy calibration kit (0.045 to 26.5 GHz)
  Contains fixed loads, open and short circuits, and adapters for both connector sexes for use with 3.5-mm test-port cables.
- 85032F 50 Ω type-N calibration kit (30 kHz to 9 GHz)
  Contains a female and male open and short, female and male load standard, and a torque wrench.
- 85033D 3.5-mm RF calibration kit (DC to 6 GHz)
  Contains fixed loads, open and short circuits, and 3.5-mm to 7-mm adapters. Option 001 deletes 3.5-mm to 7-mm adapters.
- 85033E 50 Ω 3.5-mm calibration kit (30kHz to 9 GHz)
  Contains a female and male open and short, female and male load standard, and a torque wrench.
- 85050B 7-mm standard calibration kit (0.045 to 18 GHz)
  Contains fixed loads, open and short circuits, and terminations.
- 85050C 7-mm TRL calibration kit (0.045 to 18 GHz)
  Contains fixed loads, open and short circuits, terminations, and collets.
- 85050D 7-mm economy calibration kit (0.045 to 18 GHz)
  Contains fixed loads, open and short circuits, and adapters.
- 85031B 7-mm RF calibration kit (30 kHz to 6 GHz)
  Contains open and short circuits, and a coax termination.
- 85054B type-N standard calibration kit (0.045 to 18 GHz)
  Contains fixed loads, sliding loads, open and short circuits, gages, and terminations. Option K11 adds a PSC-N slotless contact repair kit.
- 85054D type-N economy calibration kit (0.045 to 18 GHz)
  Contains fixed loads, open and short circuits, and terminationss.
- 85056A 2.4-mm standard calibration kit (0.045 to 50GHz)
  Contains fixed loads, sliding loads, open and short circuits, and adapters.
- 85056D 2.4-mm economy calibration kit (0.045 to 50 GHz)
  Contains fixed loads, open and short circuits, and adapters.

- 85056K K-connector calibration kit (2.92-mm)
  Contains 2.4-mm fixed loads, open and short circuits, and 2.4-mm to 2.92-mm adapters. Option 001 adds 2.4-mm sliding loads and gages.
- 85038A 7-16 calibration kit (30 kHz to 7.5 GHz)
  Contains male and female open and short circuits, fixed loads and wrenches.
- 85038F 7-16 (female) calibration kit (30 kHz to 7.5 GHz)
  Contains a female fixed load, open and short circuits, and adapters.
- 85038M 7-16 (male) calibration kit (30 kHz to 7.5 GHz)
  Contains a male fixed load, open and short circuits, and a male-to-male adapter.

Optical Accessories
- 11890A optical coupler
- 81000BR optical reflector (requires 81000AI connector adaptor)

Adapters
- 11904A 2.4-mm (m) to K (m) adapter
- 11904B 2.4-mm (f) to K (f) adapter
- 11904C 2.4-mm (m) to K (f) adapter
- 11904D 2.4-mm (f) to K (m) adapter
- 11904S 2.4-mm to K adapter set
- 11906A 7-16 to 7-16 adapter kit
  Contains one 7-16(m) to 7-16(m) adapter, one 7-16(f) to 7-16(f) adapter, and two 7-16(m) to 7-16(f) adapters.
- 11906B 7-16 to 50 Ω type-N adapter kit
  Contains adapters for type-N (m) to 7-16(m), type-N (m) to 7-16(f), type-N (f) to 7-16(m), and type-N (f) to 7-16(f).
- 11906C 7-16 to 7-mm adapter kit
  Contains two 7-mm to 7-16(m) adapters and two 7-mm to 7-16(f) adapters.
- 11906D 7-16 to 3.5-mm adapter kit
  Contains adapters for 3.5-mm(m) to 7-16(m), 3.5-mm(m) to 7-16(f), 3.5-mm(f) to 7-16(m), and 3.5-mm(f) to 7-16(f) adapters.
- 85130B Test Port 3.5-mm to 7-mm adapter kit
- 85130D Test Port 3.5-mm to 3.5-mm adapter kit
- 85130E Test Port 2.4-mm to 7-mm adapter kit
- 85130F Test Port 2.4-mm to 3.5-mm adapter kit
- 85130G Test Port 2.4-mm to 2.4-mm adapter kit

Optical Adapters
- 81000AI Diamond HMS 10 adapter
- 81000FI FC/PC adapter
- 81000SI DIN 47256 adapter
- 81000VI ST adapter
- 81000KI SC adapter

Verification Kits
- N1011A verification kit (85053B 3.5 mm RF verification kit is NOT recommended for use with the 8703B)

Keyboard Template

The analyzer is designed to accept most PC-AT-compatible keyboards with a mini-DIN connector. The keyboard can be used for control or data input, such as titling files. The information found on the analyzer keyboard template (part number 08753-80220) is also listed in Table 7-2.

Table 7-2. Keyboard Template Definition

Keyboard Key Name	Analyzer Function	Keyboard Key Name	Analyzer Function
F1	Softkey 1	Shift F8	CAL
F2	Softkey 2	Shift F9	MARKER
F3	Softkey 3	Shift F10	MARKER SEARCH
F4	Softkey 4	Shift F11	MARKER FUNCTION
F5	Softkey 5	Shift F12	SEQ
F6	Softkey 6	Ctrl F1	CHAN 3
F7	Softkey 7	Ctrl F2	CHAN 4
F8	Softkey 8	Ctrl F3	POWER
F9	x1	Ctrl F4	SWEEP SETUP
F10	k/m	Ctrl F5	START
F11	M/μ	Ctrl F6	STOP
F12	G/n	Ctrl F7	CENTER
Shift F1	CHAN 1	Ctrl F8	SPAN
Shift F2	CHAN 2	Ctrl F9	SYSTEM
Shift F3	MEAS	Ctrl F10	LOCAL
Shift F4	FORMAT	Ctrl F11	COPY
Shift F5	SCALE	Ctrl F12	SAVE/RECALL
Shift F6	DISPLAY	Alt F1	TITLE
Shift F7	AVG		

8

Preset State and Memory Allocation

Introduction

This chapter contains information about instrument settings that occur when

- the **Preset** key is pressed
- a preset command is sent over GPIB
- an instrument power-cycle occurs

You can also find information in this chapter on saving instrument states to internal memory locations, or to internal or external disks.

Preset State

When the **Preset** key is pressed, the analyzer reverts to a known state called the factory preset state. This state is defined in Table 8-1 on page 8-3. There are subtle differences between the preset state and the power-up state. These differences are documented in Table 8-3 on page 8-10. If power to non-volatile memory is lost, the analyzer will have certain parameters set to default settings. The affected parameters are shown in Table 8-4 on page 8-10.

When line power is cycled, the analyzer performs a self-test routine. Upon successful completion of that routine, the instrument state is set to the conditions shown in Table 8-1. The same conditions are true following a “PRES;” or “RST;” command over GPIB, although the self-test routines are not executed.

You also can create an instrument state and define it as your user preset state:

1. Set the instrument state to your desired preset conditions.
2. Save the state (save/recall menu).
3. Rename that register to “UPRESET”.
4. Press **Preset,** PRESET:USER.

The **Preset,** key is now toggled to the **USER,** selection and your defined instrument state will be recalled each time you press **Preset,** and when you turn power on. You can toggle back to the factory preset instrument state by pressing **Preset,** and selecting **FACTORY.**

NOTE	When you send a preset over GPIB, you will always get the factory preset. You can, however, activate the user-defined preset over GPIB by recalling the register in which it is stored.

Table 8-1. Preset Conditions (1 of 7)

Preset Conditions	Preset Value
Analyzer Mode	
Analyzer Mode	Network Analyzer Mode
Drive Port	lw
Offset Value	0
Stimulus Conditions	
Sweep Type	Linear Frequency
Step Sweep	On
Display Mode	Start/Stop
Trigger Type	Continuous
External Trigger	Off
Sweep Time	459 ms, Auto Mode (depends on model)
Start Frequency	50 MHz
Stop Frequency	20.05 GHz
Frequency Span	Stop Frequency--Start Frequency
Start Time	0
Time Span	100 ms
CW Frequency	1000 MHz
Source Power Setting	0 dBm
Start Power	–15.0 dBm
Power Span	20 dB
Coupled Channel Power	On
Source Power On/Off	On
Coupled Channels	On
Coupled Port Power	On
Power Range	Auto; Range 0
Laser	Internal
Number of Points	201
List Freq Sweep Mode	Stepped
Frequency List	
Frequency List	Empty

Table 8-1. Preset Conditions (2 of 7)

Preset Conditions	Preset Value
Edit Mode	Start/Stop, Number of Points
Response Conditions	
Parameter	Channel 1: Trans: O/O
	Channel 2: Trans: O/O
	Channel 3: Trans: E/O
	Channel 4: Trans: O/E (Port 1)
Conversion	Off
Format	Log Magnitude (all inputs)
Display	Data
Color Selections	Same as before **Preset**
Dual Channel	Off
Active Channel	Channel 1
Auxiliary Channel	Off
Frequency Blank	Disabled
Retrace Power	Standard
Test Set Switch	Hold
Split Display	2X
Intensity	If set to $<15\%$, Preset increases intensity to 15%. Otherwise, Preset has no effect.
Beeper: Done	On
Beeper: Warning	Off
D2/D1 to D2	Off
Title	Channel 1 = Empty
	Channel 2 = Empty
IF Bandwidth	3000 Hz
IF Averagine On/Off	Off
IF Averaging Factor	16
Smoothing Aperture On/Off	Off
Smoothing Aperture Setting	1% SPAN
Phase Offset	0 Degrees
Electrical Delay	0 ns

Table 8-1. Preset Conditions (3 of 7)

Preset Conditions	Preset Value
Scale/Division	10 dB/Division
Calibration	
Correction	Off
Calibration Type	None
Calibration Kit	3.5-mm
Enhanced Reflection Calibration	Off
System Z0	50 Ohms
Velocity Factor	1
Extensions	Off
Port 1	0 s
Port 2	0 s
Input A	0 s
Input B	0 s
Optical Output	0 s
Chop A and B	On
Power Meter Calibration	Off
Number of Readings	1
Power Loss Correction	Off
Sensor A/B	A
Interpolated Error Correction	On
Index of Refraction	1
Wavelength	1550 nm
Magnitude Offset	dB
Markers (coupled)	
Markers On/Off	All Markers Off
Marker Setting (all Markers)	1 GHz
Last Active Marker	1
Reference Marker	None
Marker Mode	Continuous
Display Markers	On
Delta Marker Mode	Off

Table 8-1. Preset Conditions (4 of 7)

Preset Conditions	Preset Value
Coupling	On
Marker Search	Off
Marker Target Value	–3 dB
Marker Width On/Off	Off
Marker Width Value	–3 dB
Marker Tracking	Off
Marker Stimulus Offset	0 Hz
Marker Value Offset	0 dB
Marker Aux Offset (Phase)	0 Degrees
Marker Statistics	Off
Polar Marker	Lin Mkr
Smith Marker	R+jX Mkr
Limit Menu	
Limit Lines	
Limit Lines	Off
Limit Testing	Off
Limit List	Empty
Edit Mode	Upper Limits, Lower Limits
Stimulus Offset	0 Hz
Amplitude Offset	0 dB
Limit Type	Sloping Line
Beep Fail	Off
Ripple Limit	
Ripple Limit	Off
Ripple Test	Off
Bandwidth Limit	
Bandwidth Test	Off
Bandwidth Display	Off
Bandwidth Marker	Off
System Parameters	
GPIB Addresses	Last Active State

Table 8-1. Preset Conditions (5 of 7)

Preset Conditions	Preset Value
GPIB Mode	Last Active State
Clock Time Stamp	On
Preset: Factory/User	Last Selected State
Copy Configuration	
Parallel Port	Last Active State
Plotter Type	Last Active State
Plotter Port	Last Active State
Plotter Baud Rate	Last Active State
Plotter Handshake	Last Active State
GPIB Address	Last Active State
Printer Type	Last Active State
Printer Port	Last Active State
Printer Baud Rate	Last Active State
Printer Handshake	Last Active State
Printer GPIB Address	Last Active State
Disk Save Configuration (Define Store)	
Data Array	Off
Raw Data Array	Off
Formatted Data Array	Off
Graphics	Off
Data Only	Off
Directory Size	Default[a]
Save Using	Binary
Select Disk	Internal Memory
Disk Format	DOS
Sequencing[b]	Preset switches off sequencing modify (edit) mode and stops any running sequence.
Loop Counter	0
TTL OUT	High
Service Modes	
GPIB Diagnostic	Off

Table 8-1. Preset Conditions (6 of 7)

Preset Conditions	Preset Value
Source Phase Lock	Loop On
Aux Input Resolution	Low
Analog Bus Node	11 (Aux Input)
Laser	ON
Bias Mode	ON (AUTO)
Receiv Out	OPT
Coupled SW	ON
B Sampler	LW
Plot	
Plot Data	On
Plot Memory	On
Plot Graticule	On
Plot Text	On
Plot Marker	On
Autofeed	On
Plot Quadrant	Full Page
Scale Plot	Full
Plot Speed	Fast
Pen Number:	
Ch1/Ch3 Data	2
Ch2/Ch4 Data	3
Ch1/Ch3 Memory	5
Ch2/Ch4 Memory	6
Ch1/Ch3 Graticule	1
Ch2/Ch4 Graticule	1
Ch1/Ch3 Text	7
Ch2/Ch4 Text	7
Ch1/Ch3 Marker	7
Ch2/Ch4 Marker	7
Line Type:	

Table 8-1. Preset Conditions (7 of 7)

Preset Conditions	Preset Value
Ch1/Ch3 Data	7
Ch2/Ch4 Data	7
Ch1/Ch3 Memory	7
Ch2/Ch4 Memory	7
Print	
Printer Mode	Last Active State
Auto-Feed	On
Printer Colors	
Ch1/Ch3 Data	Magenta
Ch1/Ch3 Mem	Green
Ch2/Ch4 Data	Blue
Ch2/Ch4 Mem	Red
Graticule	Cyan
Warning	Black
Text	Black
Reference Line	Black

a. The directory size is calculated as 0.013% of the floppy disk size (which is ≈256) or 0.005% of the hard disk size.
b. Pressing preset turns off sequencing modify (edit) mode and stops any running sequence.

Table 8-2. Preset Conditions

Format Table	Scale	Reference	
		Position	Value
Log Magnitude (dB)	10.0	5.0	0.0
Phase (degree)	90.0	5.0	0.0
Group Delay (ns)	10.0	5.0	0.0
Smith Chart	1.00	NA	1.0
Polar	1.00	NA	1.0
Linear Magnitude	0.1	0.0	0.0
Real	0.2	5.0	0.0
Imaginary	0.2	5.0	0.0
SWR	1.00	0.0	1.0

Table 8-3. Power-On Conditions (versus Preset)

GPIB MODE	Talker/listener.
SAVE REGISTERS	Power meter calibration data and calibration data not associated with an instrument state are cleared.
COLOR DISPLAY	Default color values.
SEQUENCES	Sequence 1 through 5 are erased.
DISK DIRECTORY	Cleared.

Table 8-4. Results of Power Loss to Non-Volatile Memory

GPIB ADDRESSES are set to the following defaults:	
ANALYZER	16
USER DISPLAY	17
PLOTTER	5
PRINTER	1
POWER METER	13
DISK	0
DISK UNIT NUMBER	0
DISK VOLUME NUMBER	0
POWER METER TYPE is set to 438A/437	
INTERNAL REGISTER TITLES[a] are set to defaults: REG1 through REG32	
EXTERNAL REGISTER TITLES[a] (store files) are set to defaults: FILE1 through FILE 5	
PRINT TYPE is set to default: MONOCHROME	
PRINTING/PLOTTING SETUPS are set to the following defaults:	
PARALLEL PORT	COPY
PLOTTER TYPE	PLOTTER
PLOTTER PORT	GPIB
PLOTTER BAUD RATE	9600
PLOTTER HANDSHAKE	Xon-Xoff
PRINTER TYPE	DESKJET
PRINTER PORT	PARALLEL
PRINTER BAUD RATE	19200
PRINTER HANDSHAKE	Xon-Xoff

a. Only applies to GPIB operation.

Memory Allocation

The analyzer is capable of saving complete instrument states for later retrieval. It can store these instrument states into the internal memory, to the internal disk, or to an external disk. This section contains information on the following subjects:

- "Types of Memory and Data Storage" (below)
- "Determining Memory Requirements" on page 8-12
- "Storing Data to Disk" on page 8-14
- "Conserving Memory" on page 8-16
- "Using Saved Calibration Sets" on page 8-16

Types of Memory and Data Storage

The analyzer utilizes two types of internal memory and can also utilize the internal disk drive or be connected to an external disk drive:

Volatile Memory

This is dynamic read/write memory, of approximately 4 Mbytes, that contains all of the parameters that make up the *current* instrument state. An instrument state consists of all the stimulus and response parameters that set up the analyzer to make a specific measurement. Some data that you may think is part of the instrument state (such as calibration data and memory traces) are actually stored in non-volatile memory. See "Non-Volatile Memory" to read more about the differences. Volatile memory is cleared upon a power cycle of the instrument and, except as noted, upon instrument preset.

Non-Volatile Memory

This is CMOS read/write memory that is protected by a battery to provide storage of data when line power to the instrument is turned off. With this battery protection, data can be retained in memory for ≈ 250 days at 70 °C and for ≈ 10 years at 25 °C (characteristically). Non-volatile memory consists of a block of user-allocated memory and a block of fixed memory. The user-allocated memory is available for you to save the following data:

- instrument states
- measurement calibration data
- power meter calibration data
- user calibration kit definitions
- memory traces
- user preset

NOTE	Even though calibration data is stored in non-volatile memory, if the associated instrument state is not saved, you will not be able to retrieve the calibration data after a power cycle.

The fixed memory is used to store the following data (you cannot change where this data is stored and it does not affect your memory availability for storing user-allocated data):

- GPIB addresses
- copy configuration (printer and plotter type, port, baud rate, handshake)
- power meter type (436/437/438)
- display colors

- sequence titles
- sixth sequence
- power sensor calibration factors and loss tables
- user-defined calibration kits
- system Z0
- factory preset
- GPIB configuration
- display intensity default

The maximum number of instrument states, calibrations, and memory traces that can reside in non-volatile memory at any one time is limited to 31 instrument states, 128 calibrations (4 per instrument state, including the present instrument state), and 64 memory traces (4 per instrument state, including the present instrument state).

In addition, the number of instrument states and associated calibrations and memory traces are limited by the available memory. To display the amount of unused memory on the analyzer, press **Save/Recall.** (Be sure you have selected **INTERNAL MEMORY,** as your disk type.) In the upper right-hand portion of the display, the value displayed as `Bytes free:` is the unused non-volatile memory. When you save to the internal memory, you will see the number of bytes free decrease. When you delete files, the number of bytes free increases. There is a maximum of 2 MBytes available.

If you have deleted registers since the last time the instrument was preset, the bytes available for you to use may be less than the actual “bytes free” that is displayed. Deleting registers to increase the available memory will work in cases where the registers being deleted and the registers needing to be added are of the same standard size (such as instrument states not having calibrations associated with them). In certain other cases, however, you may have to press **Preset,** after deleting registers so that the “bytes free” value equals the available memory value. During a preset, the analyzer runs a memory packer that de-fragments the free memory into one contiguous block.

Determining Memory Requirements

Table 8-5 shows the memory requirements of calibration arrays and memory trace arrays to help you approximate memory requirements. For example, add the following memory requirements:

- a full 2-port calibration with 801 points (58 k)
- the memory trace array (4.9 k)
- the instrument state (6 k)

The total memory requirement is 68.9 kbytes. There is sufficient memory to store 29 calibrations of this type. However, the same calibration performed with 1601 points and 2 channels uncoupled would require 255 k bytes:

- a full 2-port calibration with 1601 points, two channels, uncoupled (230 k)
- the memory trace array (19 k)
- the instrument state (6 k)

Only 2 of these calibrations could reside in memory before the available memory would be depleted.

Table 8-5. Memory Requirements of Calibration and Memory Trace Arrays

Calibration Arrays	Data Length (Bytes)[a]	Approximate Totals (Bytes)			
		401 pts	801 pts	1601 pts	
		1 chan		1 chan	2 chans
Reflection 0 and Transmission 0/0					
Response	$N \times 6 + 52$	2.5 k	5 k	10 k	19 k
Response and isol.	$N \times 6 \times 2 + 52$	5 k	10 k	19 k	38 k
	$N \times 6 \times 3 + 52$	7 k	14 k	29 k	58 k
Transmission E/0					
Response					
Response and isol.	$N \times 6 \times 3+ 52$	7 k	14 k	29 k	58 k
Response and match	$N \times 6 \times 4 + 52$	9.7 k	19.3 k	38.5 k	77 k
	$N \times 6 \times 7 + 52$	17 k	33.7 k	67.3 k	134.5k
Transmission E/0					
Response					
Response and isol.	$N \times 6 \times 2 + 52$	5 k	10 k	19 k	38 k
Response and match	$N \times 6 \times 3+ 52$	7 k	14 k	29 k	58 k
	$N \times 6 \times 10+ 52$	24.1 k	48.1 k	96.1 k	192.2k
Reflection and Transmission E/E					
Response	$N \times 6 + 52$	2.5 k	5 k	10 k	19 k
Response and isol.	$N \times 6 \times 2 + 52$	5 k	10 k	19 k	38 k
1-Port	$N \times 6 \times 3 + 52$	7 k	14 k	29 k	58 k
2-Port	$N \times 6 \times 12 + 52$	29 k	58 k	115 k	230 k
Interpolated cal	Same as above in addition to regular cal				
Power Meter Cal[b]	($N^{c} \times 2 \times$ number channels[d]) +208	1 k	1.8 k	3.4 k	6.6 k
Measurement Data					
Memory trace array[b]	$N \times 6 + 52$	2.5 k	4.9 k	9.7 k	19 k
Instrument State[e]		6 k	6 k	6 k	6 k

a. N = number of points
b. This variable is allocated once per active channel.
c. The number of points that was set at the time the cal was turned on.

d. If the channels are coupled, this number is always 1. If the channels are uncoupled, this number refers to the number of channels that have power meter cal on.
e. This value may change with different firmware revisions.

The analyzer attempts to allocate memory at the start of a calibration. If insufficient memory is available, an error message is displayed. It is possible that the CMOS memory might be fragmented due to the sequence of saving and deleting states of various sizes. So another alternative would be to store the current state to disk and then press **Preset.** The analyzer runs a memory packer which might regain some previously inaccessible memory. If memory is still inadequate, delete an instrument state and restart the calibration.

Storing Data to Disk

You can use the internal disk drive or connect an external disk drive for storage of instrument states, calibration data, measurement data, and plot files. (Refer to user's guide for more information on saving measurement data and plot files.)

The analyzer displays one file name per stored instrument state when you list the disk directory. In reality, several files are actually stored to the disk when you store the instrument state. Thus, when the disk directory is accessed from a remote system controller, the directory will show several files associated with a particular saved state. The maximum number of files that you can store on a disk depends on the directory size. You can define the directory size when you format a disk. For the default directory size for floppy disks and hard disks, refer to Table 8-1.

The maximum number of instrument states and calibrations that can reside on a disk is limited by the available disk space. To see the available disk space displayed on the analyzer, press **Save/Recall.** (Be sure you have selected either **INTERNAL DISK,** or **EXTERNAL DISK,** depending on your disk type.) In the upper right-hand portion of the display, the value displayed as `Bytes free:` is the available disk space. If your disk is formatted in LIF, this value is the largest contiguous block of disk space. Since the analyzer is reporting the largest contiguous block of disk space, you may or may not see the bytes free number change when you delete files. If your disk is formatted in DOS, the number reported as bytes free is the total available disk space. That number is updated whenever you save to or delete files from the disk.

A disk file created by the analyzer appends a suffix to the file name. (This is on the analyzer's directory and is not visible.) The suffix consists of one or two characters: the first character is the file type and the second is a data index. (Each suffix character is defined in Table 8-6.)

Table 8-6. Suffix Character Definitions

Char 1	Definition	Char 2	Definition
I, P	Instrument state[a]		
W	Four-channel instrument state		
G	Graphics	**1**	Display graphics
		0	Graphics index
D	Error corrected data	**1**	Channel 1
		2	Channel 2
		3	Channel 3
		4	Channel 4
R	Raw data	**1 to 4**	Channel 1/3, raw arrays 1 to 4[b]
		5 to 8	Channel 2/4, raw arrays 5 to 8
F	Formatted data	**1**	Channel 1
		2	Channel 2
		3	Channel 3
		4	Channel 4
C	Cal	**K**	Cal kit
1	Cal data, channel 1	**0**	Stimulus state
		1 to 9	Coefficients 1 to 9
		A	Coefficient 10
		B	Coefficient 11
		C	Coefficient 12
2	Cal data, channel 2	**0 to C**	same as channel 1
M	Memory trace data	**1**	Channel 1
		2	Channel 2
		3	Channel 3
		4	Channel 4
S	Error corrected data (S2P)[c]	**1**	Channel 1
		2	Channel 2

a. These are two-channel instrument states readable by previous firmware versions.
b. Files R1 through R8 will be saved if a full two-port calibration is active. Otherwise, only R1 is saved for Channel 1, R5 for Channel 3, R2 for Channel 2, and R6 for Channel 4.
c. These files are written only when a 2-port error correction (full 2-port or TRL) has been applied.

If correction is on at the time of an external store, the calibration set is stored to disk. (Note that inactive calibrations are not stored to disk.) When an instrument state is loaded into the analyzer from disk, the stimulus and response parameters are restored first. If correction is on for the loaded state, the analyzer will load a calibration set from disk that carries the same title as the one stored for the instrument state.

Conserving Memory

If you are concerned about conserving memory, either internal memory or external disk space, some of the most memory-intensive operations include:

- two-port error correction
- interpolated error correction
- 1601 measurement points
- saving data arrays and graphics with the instrument state

Using Saved Calibration Sets

When you are saving to internal memory (CMOS, non-volatile memory), calibration sets are linked to the instrument state and measurement parameter for which the calibration was done. Therefore a saved calibration can be used for multiple instrument states as long as the measurement parameter, frequency range, and number of points are the same. A full 2-port calibration is valid for any measurement with the same frequency range and number of points. When an instrument state is deleted from memory, the associated calibration set is also deleted if it is unused by any other state.

The following hints will help you avoid potential problems:

- If a measurement is saved with calibration and interpolated calibration on, it will be restored with interpolated calibration on.
- A calibration stored from one instrument and recalled by a different one will be invalid. To ensure maximum accuracy, always recalibrate in these circumstances.
- No record is kept in memory of the temperature when a calibration set was stored. Instrument characteristics change as a function of temperature, and a calibration stored at one temperature may be inaccurate if recalled and used at a different temperature. Refer to Chapter 1, “Specifications and Regulatory Information”.

9

Understanding the CITIfile Data Format

Introduction

This chapter explains the use of the CITIfile (Common Instrumentation Transfer and Interchange file) format for the storage and transfer of measurement and data information. Several examples of CITIfiles have been included in this chapter to demonstrate how the format can used to simplify the transfer of measurement and data information between instruments and computers. For many data processing applications, the S2P file (filename.S1 and filename.S2) may provide a more convenient format.

The CITIfile Data Format

CITIfile is a standardized data format, used for exchanging data between different computers and instruments. CITIfile is an abbreviation for "Common Instrumentation Transfer and Interchange file". This standard has been a group effort between instrument designers and designers of computer-aided design programs. As much as possible, CITIfile meets current needs for data transfer, and it was designed to be expandable so it can meet future needs.

CITIfile defines how the data inside an ASCII package is formatted. Since it is not tied to any particular disk or transfer format, it can be used with any operating system (BASIC, DOS, UNIX, etc.), with any disk format (LIF, DOS, HFS, etc.), or with any transfer mechanism (disk, LAN, GPIB, etc.). By careful implementation of the standard, instruments and software packages using CITIfile are able to load and work with data created on another instrument or computer. It is possible, for example, for a network analyzer to directly load and display data measured on a scalar analyzer, or for a software package running on a computer to read data measured on a lightwave component analyzer.

Data Formats

There are two main types of data formats: binary and ASCII. CITIfile uses the ASCII text format. While this format does take up more bytes of space than a binary format, ASCII data is a transportable, standard type of format which is supported by all operating systems. In addition, the ASCII format is accepted by most text editors. This allows files to be created, examined, and edited easily, making CITIfile easier to test and debug.

File and Operating System Formats

CITIfile was designed to be independent of the data storage mechanism, and therefore may be implemented for any file system. However transfer between file systems may sometimes be necessary. Any commercially available software that has the ability to transfer ASCII files between systems may be used to transfer CITIfile data.

Definition of CITIfile Terms

This section will define the following terms:

- package
- header
- data array
- keyword

A CITIfile Package

A typical package is divided into two parts: The first part, the header, is made up of keywords and setup information. The second part, the data, usually consists of one or more arrays of data. Example 1 shows the basic structure of a CITIfile package:

Example 1, A CITIfile Package

The "header" part	CITIFILE A.01.00
	NAME MEMORY
	VAR FREQ MAG 3
	DATA S RI
The "data" part	BEGIN
	-3.54545E-2, -1.38601E-3
	0.23491E-3, -1.39883QE-3
	2.00382E-3, -1.40022E-3
	END

When stored in a disk file there may be more than one CITIfile package. With the 8510 network analyzer, for example, storing a "memory all" will save all eight of the memories held in the instrument. This results in a single file which contains eight CITIfile packages.

The CITIfile Header

The header section contains information about the data that will follow. It may also include information about the setup of the instrument that measured the data. For example, the header may include information such as:

- CITIfile version number
- Analyzer model number
- Firmware revision currently installed in the analyzer
- Type of Data
- Data Format
- Measurement parameters
- Start and stop frequencies
- Number of sample points

The CITIfile header shown in Example 1 has just the bare minimum of information necessary; no instrument setup information was included.

An Array of Data

An array is numeric data that is arranged with one data element per line. In the Smith chart and polar formats, the data is in real and imaginary pairs. In all other formats, the data is still in pairs, but the second term of the pair is 0E0. All information is true formatted data in the same format as on the analyzer display (dB, SWR, etc.). A CITIfile package may contain more than one array of data. Arrays of data start after the BEGIN keyword, and the END keyword will follow the last data element in an array. A CITIfile package does not necessarily need to include data arrays; for instance, CITIfile could be used to store the current state of an instrument. In that case the keywords VAR, DATA, BEGIN, and END would not be required.

CITIfile Keyword

Keywords are always the first word on a new line. They are always one continuous word without embedded spaces. A listing of all the keywords used in the latest A.01.01 version of CITIfile is shown in "CITIfile

Keywords." When reading a CITIfile, unrecognized keywords should be ignored. This allows new keywords to be added, without affecting an older program or instrument that might not use the new keywords. The older instrument or program can still use the rest of the data in the CITIfile as it did before. Ignoring unknown keywords allows backwards compatibility to be maintained.

CITIfile Examples

Example 2, An 8510 Display Memory File

Example 2 shows a simple file that contains no frequency information. Some instruments do not keep frequency information for display memory data, so this information is not included in the CITIfile package. Note that instrument-specific information (#NA= Network Analyzer information) is also stored in this file. This convention allows the designer to define keywords that are particular to his or her particular implementation.

Example:

```
CITIFILE A.01.00
#NA VERSION 8510B.05.00
NAME MEMORY
#NA REGISTER 1
VAR FREQ MAG 5
DATA S RI
BEGIN
-1.31189E-3,-1.47980E-3
-3.67867E-3,-0.67782E-3
-3.43990E-3,0.58746E-3
-2.70664E-4,-9.76175E-4
0.65892E-4,-9.61571E-4
END
```

Example 3, 8510 Data file

Example 3 shows a CITIfile package created from the data register of an 8510 Network Analyzer. In this case 10 points of real and imaginary data was stored, and frequency information was recorded in a segment list table.

Example:

```
CITIFILE A.01.00
#NA VERSION 8510B.05.00
NAME DATA
#NA REGISTER 1
VAR FREQ MAG 10
DATA S[1,1] RI
SEG_LIST_BEGIN
SEG 1000000000 4000000000 10
SEG_LIST_END
BEGIN
0.86303E-1,-8.98651E-1
8.97491E-1,3.06915E-1
-4.96887E-1,7.87323E-1
-5.65338E-1,-7.05291E-1
8.94287E-1,-4.25537E-1
1.77551E-1,8.96606E-1
-9.35028E-1,-1.10504E-1
```

```
3.69079E-1,-9.13787E-1
7.80120E-1,5.37841E-1
-7.78350E-1,5.72082E-1
END
```

Example 4, 8510 3-Term Frequency List Cal Set File

Example 4 shows how CITIfile may be used to store instrument setup information. In the case of an 8510 Cal Set, a limited instrument state is needed in order to return the instrument to the same state that it was in when the calibration was done. Three arrays of error correction data are defined by using three DATA statements. Some instruments require these arrays to be in the proper order, from E1 to E3. In general, CITIfile implementations should strive to handle data arrays that are arranged in any order.

Example:

```
CITIFILE A.01.00
#NA VERSION 8510B.05.00
NAME CAL_SET
#NA REGISTER 1
VAR FREQ MAG 4
DATA E[1] RI
DATA E[2] RI
DATA E[3] RI
#NA SWEEP_TIME 9.999987E-2
#NA POWER1 1.0E1
#NA POWER2 1.0E1
#NA PARAMS 2
#NA CAL_TYPE 3
#NA POWER_SLOPE 0.0E0
#NA SLOPE_MODE 0
#NA TRIM_SWEEP 0
#NA SWEEP_MODE 4
#NA LOWPASS_FLAG -1
#NA FREQ_INFO 1
#NA SPAN 1000000000 3000000000 4
#NA DUPLICATES 0
#NA ARB_SEG 1000000000 1000000000 1
#NA ARB_SEG 2000000000 3000000000 3
VAR_LIST_BEGIN
1000000000
2000000000
2500000000
3000000000
VAR_LIST_END
BEGIN
1.12134E-3,1.73103E-3
4.23145E-3,-5.36775E-3
-0.56815E-3,5.32650E-3
-1.85942E-3,-4.07981E-3
END
BEGIN
2.03895E-2,-0.82674E-2
-4.21371E-2,-0.24871E-2
0.21038E-2,-3.06778E-2
1.20315E-2,5.99861E-2
END
```

```
BEGIN
4.45404E-1,4.31518E-1
8.34777E-1,-1.33056E-1
-7.09137E-1,5.58410E-1
4.84252E-1,-8.07098E-1
END
```

When an instrument's frequency list mode is used, as it was in Example 4, a list of frequencies is stored in the file after the VAR_LIST_BEGIN statement. The unsorted frequency list segments used by this instrument to create the VAR_LIST_BEGIN data are defined in the #NA ARB_SEG statements.

CITIfile Keywords

Keyword	Explanation and Examples
CITIFILE	CITIFILE A.01.01 identifies the file as a CITIfile, and indicates the revision level of the file. The CITIfile keyword and revision code must precede any other keywords. The CITIfile keyword at the beginning of the package assures the device reading the file that the data that follows is in the CITIfile format. The revision number allows for future extensions of the CITIfile standard. The revision code shown here following the CITIfile keyword indicates that the machine writing this file is using the A.01.01 version of CITIfile as defined here. Any future extensions of CITIfile will increment the revision code.
NAME	NAME CAL_SET allows the current CITIfile "package" to be named. The name of the package should be a single word with no embedded spaces. A list of standard package names follows:
Label	Definition.
RAW_DATA	Uncorrected data.
DATA	Data that has been error corrected.When only a single data array exists, it should be named DATA.
FORMATTED	Corrected and formatted data.
MEMORY	Data trace stored for comparison purposes.
CAL_SET	Coefficients used for error correction.
CAL_KIT	Description of the standards used.
DELAY_TABLE	Delay coefficients for calibration.
VAR	VAR FREQ MAG 201 defines the name of the independent variable (FREQ), the format of values in a VAR_LIST_BEGIN table (MAG, if used), and the number of data points (201).Typical names for the independent variable are FREQ (in Hz), TIME (in seconds), and POWER (in dBm). For the VAR_LIST_BEGIN table, only the "MAG" format is supported at this point. # #NA POWER1 1.0E1 allows variables specific to a particular type of device to be defined. The pound sign (#) tells the device reading the file that the following variable is for a particular device. The "NA" shown here indicates that

	the information is for a Network Analyzer. This convention allows new devices to be defined without fear of conflict with keywords for previously defined devices. The device identifier (i.e. NA) may be any number of characters.
SEG_LIST_BEGIN	SEG_LIST_BEGIN indicates that a list of segments for the independent variable follow. Format for the segments is: [segment type] [start] [stop] [number of points]. The current implementation only supports a single segment. If there is more than one segment, the VAR_LIST_BEGIN construct is used. CITIfile revision A.01.00 supports only the SEG (linear segment) segment type.
SEG_LIST_END	SEG_LIST_END defines the end of a list of independent variable segments.
VAR_LIST_BEGIN	VAR_LIST_BEGIN indicates that a list of the values for the independent variable (declared in the VAR statement) follow. Only the MAG format is supported in revision A.01.00.
VAR_LIST_END	VAR_LIST_END defines the end of a list of values for the independent variable.
DATA	DATA S[1,1] RI defines the name of an array of data that will be read later in the current CITIfile package, and the format that the data will be in. Multiple arrays of data are supported by using standard array indexing. Versions A.01.00 and A.01.01 of CITIfile only support the RI (real and imaginary) format, and a maximum of two array indexes. Commonly used array names include the following: "S" for "S parameter" Example: S[2,1] "E" for "Error term" Example: E[1] "USER" for "User parameter" Example: USER[1] "VOLTAGE" Example: VOLTAGE[1] "VOLTAGE_RATIO" for a ratio of Example: VOLTAGE_RATIO[1,0] two voltages (A/R).
CONSTANT	

CONSTANT [name] [value] allows for the recording of values which don't change when the independent variable changes. CONSTANTs are part of the main CITIfile definition. Users must not define their own CONSTANTs. Use the #KEYWORD device specification to create your own KEYWORD instead. The #NA device specification is an example of this. No constants were defined for revision A.01.00 of CITIfile. CITIfile revision A.01.01 defined the following constant:

CONSTANTs are part of the main CITIfile definition. Users must not define their own CONSTANTs. Use the #KEYWORD device specification to create your own KEYWORD instead. The #NA device specification is an example of this. No constants were defined for revision A.01.00 of CITIfile. CITIfile revision A.01.01 defined the following constant:

CONSTANT TIME [year] [month] [day] [hour] [min] [secs] Example:

COMMENT	YEAR	MONTH	DAY	HOUR	MINUTE	SECONDS
CONSTANT TIME	1999	02	26	17	33	53.25

- The COMMENT statement is not absolutely required, but is highly recommended to aid readability.
- The year should always be the full four digits ("1999" is correct, but "99" is not). This is to avoid

problems with the year 2000, when the shortened version of the year will be "00."

- The hour value should be in 24-hour "military" time.
- When writing a CITIfile and the fractional seconds value is zero, then the "seconds" value may be printed either with or without a decimal point: either "47.0" or "47" would be acceptable. When reading a CITIfile, the seconds value should always be read as if it were a floating point number.

Useful Calculations

This section contains information on computing frequency points and expressing CITIfile data in other data formats.

Computing Frequency Points

In CITIfile, the frequency data is not listed point by point, only the start and stop values are given. If you are using a spreadsheet program, you can create a new frequency column to the left of the data pairs. Use the following formula to obtain each frequency point:

Fn = Fstart + {(n-1) * [(Fstop - Fstart) / (# of points - 1)]}

where:

Fstart = Start Frequency
Fstop = Stop Frequency
Fn = Frequency point with n being an integer
# of points = number of sample points per sweep

Here is an example of how this formula may be entered:

F1 = 30E3 + {(1-1) * [(6E9 - 30E3) / (201 - 1)]} = 30E3 = 30 kHz
F2 = 30E3 + {(2-1) * [(6E9 - 30E3) / (201 - 1)]} = 30E6 = 30 MHz
F201 = 30E3 + {(201 - 1) * [(6E9 - 30E3) / (201 - 1)]} = 6E9 = 6 GHz

Once these cells are entered, copy the formula to the remaining data points, and the frequency will be indicated for each row.

Expressing CITIfile Data in Other Data Formats

CITIfile data is represented in real and imaginary pairs. Equations can be used to express this information in logarithmic magnitude, phase, polar, and Smith chart formats. Refer to the following table for these equations.

Desired Format	Mathematical Equation[a]	Microsoft Excel Command[b]
Log Magnitude	20*Log10((Re2 + Im2)) 1/2	=20*LOG10(SQRT((SUMSQ(ReCell 1,Im Cell 1)))) (dB)
Phase	tan-1(Im/Re) or arctan (Im/Re)	ATAN2(ReCell 1, ImCell 1)*180/PI() (Degree)
Polar	Magnitude = ((Re2 + Im2)) 1/2 Phase = tan-1(Im/Re) or arctan (Im/Re)	Magnitude = (SQRT((SUMSQ(ReCell 1,Im Cell 1))) Phase = ATAN2(ReCell 1, ImCell 1)*180/PI()
Smith Chart (Marker)	Resistance = (1 - Re2-Im2) / ((1 -Re) 2+Im2)) * Z0 Reactance = (2*Im) / ((1 - Re) 2+Im2)) * Z0	Resistance = ((1-POWER(ReCell 1,2)-POWER(ImCell 1,2)) / (POWER((1- ReCell 1),2)+POWER(ImCell 1,2))) * Z Cell 1 Reactance = (2*ImCell 1) / (POWER((1- ReCell 1),2)+POWER(ImCell 1,2)))*Z Cell 1

a. Re = real. Im = imaginary.

b. The references to ReCell 1, ImCell 1, and Z Cell 1 refer to the real and imaginary data pair numeric values that have been entered into specific cells in the Microsoft Excel spread sheet.

Example Data

This example shows how the following CITIfile data for a three-point trace can be expressed in other data formats.

```
CITIFILE A.01.00
#NA VERSION 8753E.07.12
NAME DATA
VAR FREQ MAG 3.0000
DATA S[11] RI
SEG_LIST_BEGIN
SEG 1550000000 1570000000 3.0000
SEG_LIST_END
BEGIN
```

Table 9-1. Data Values

				Calculated Smith Chart Readings		Calculated Polar Readings	
Real Value	**Imag Value**	**Calculated LogMag**	**Calculated Phase**	**Resistance**	**Reactance**	**Magnitude**	**Phase**
4.43E–02	–4.52E–01	–6.8593	–84.4025	35.5204	–40.4294	0.4539	–84.4025
–6.32E–02	–4.47E–01	–6.9150	–98.0545	29.9477	–33.5840	0.4510	–98.0545
–1.66E–01	–4.38E–01	–6.5847	–110.7272	25.1562	–28.2510	0.4685	–110.727

Table 9-2. Marker Reading Values

Log Mag (Marker)	Phase (Marker)	S11 Smith Chart Resistance (Marker)	S11 Smith Chart Reactance (Marker)	Polar Magnitude (Marker)
–6.859	–84.403	35.520	–40.429	454.98mU
–6.915	–98.055	29.948	–33.584	451.07mU
–6.585	–110.737	25.156	–28.251	468.56mU

10

Returning the Agilent 8703B for Service

Returning the Instrument for Service

The instructions in this section show you how to properly package the instrument for return to a Agilent Technologies service office. For a list of offices, refer to “Agilent Technologies Service Offices” on page 10-4.

If the instrument is still under warranty or is covered by an Agilent maintenance contract, it will be repaired under the terms of the warranty or contract (the warranty is at the front of this manual). If the instrument is no longer under warranty or is not covered by an Agilent maintenance plan, Agilent will notify you of the cost of the repair after examining the unit.

When an instrument is returned to a Agilent service office for servicing, ship the analyzer using the original packaging materials. Returning the analyzer in anything other than the original packaging may result in non-warranted damage.

Include a complete description of any failure symptoms. When describing a failure, please be as specific as possible about the nature of the problem. Include copies of additional failure information (such as the instrument failure settings, data related to instrument failure, and error messages) along with the original cal data disks and the instrument being returned.

Please notify the service office before returning your instrument for service. Any special arrangements for the instrument can be discussed at this time. This will help the Agilent service office repair and return your instrument as quickly as possible.

Preparing the instrument for shipping

1. Write a complete description of the failure and attach it to the instrument. Include any specific performance details related to the problem. The following information should be returned with the instrument.

- Type of service required.
- Date instrument was returned for repair.
- Description of the problem:
  - Whether problem is constant or intermittent.
  - Whether instrument is temperature-sensitive.
  - Whether instrument is vibration-sensitive.
  - Instrument settings required to reproduce the problem.
  - Performance data.
- Company name and return address.
- Name and phone number of technical contact person.
- Model number of returned instrument.
- Full serial number of returned instrument.
- List of any accessories returned with instrument.
- The original cal data disks.

2. Cover all front or rear-panel connectors that were originally covered when you first received the instrument.

CAUTION	Cover electrical connectors to protect sensitive components from electrostatic damage. Cover optical connectors to protect them from damage due to physical contact or dust.

CAUTION Instrument damage can result from using packaging materials other than the original materials. Never use styrene pellets as packaging material. They do not adequately cushion the instrument or prevent it from shifting in the carton. They may also cause instrument damage by generating static electricity.

3. Pack the instrument in the original shipping containers. Original materials are available through any Agilent office. Or, use the following guidelines:

- Wrap the instrument in antistatic plastic to reduce the possibility of damage caused by electrostatic discharge.
- For instruments weighing less than 54 kg (120 lb), use a double-walled, corrugated cardboard carton of 159 kg (350 lb) test strength.
- The carton must be large enough to allow approximately 7 cm (3 inches) on all sides of the instrument for packing material, and strong enough to accommodate the weight of the instrument.
- Surround the equipment with approximately 7 cm (3 inches) of packing material, to protect the instrument and prevent it from moving in the carton. If packing foam is not available, the best alternative is S.D-240 Air Cap™ from Sealed Air Corporation (Commerce, California 90001). Air Cap looks like a plastic sheet filled with air bubbles. Use the pink (antistatic) Air Cap™ to reduce static electricity. Wrapping the instrument several times in this material will protect the instrument and prevent it from moving in the carton.

4. Seal the carton with strong nylon adhesive tape.
5. Mark the carton “FRAGILE, HANDLE WITH CARE”.
6. Retain copies of all shipping papers.

Agilent Technologies Service Offices

Before returning an instrument for service, call the Agilent Technologies Instrument Support Center at (800) 403-0801, visit the Test and Measurement Web Sites by Country page at http://www.tm.agilent.com/tmo/country/English/index.html, or call one of the numbers listed below.

Table 10-1. Agilent Technologies Service Numbers

Austria	01/25125-7171
Belgium	32-2-778.37.71
Brazil	(11) 7297-8600
China	86 10 6261 3819
Denmark	45 99 12 88
Finland	358-10-855-2360
France	01.69.82.66.66
Germany	0180/524-6330
India	080-34 35788
Italy	+39 02 9212 2701
Ireland	01 615 8222
Japan	(81)-426-56-7832
Korea	82/2-3770-0419
Mexico	(5) 258-4826
Netherlands	020-547 6463
Norway	22 73 57 59
Russia	+7-095-797-3930
Spain	(34/91) 631 1213
Sweden	08-5064 8700
Switzerland	(01) 735 7200
United Kingdom	01 344 366666
United States and Canada	(800) 403-0801

Index